WPS5647

Policy Research Working Paper 5647

Politics and Preschool

The Political Economy of Investment in Pre-Primary Education

Katrina Kosec

The World Bank
Latin America and the Caribbean Region
Human Development Department
May 2011

Policy Research Working Paper 5647

Abstract

What drives governments with similar revenues to publicly provide very different amounts of goods for which private substitutes are available? Key examples are education and health care. This paper compares spending by Brazilian municipalities on pre-primary education—a good that is also provided privately—with spending on public infrastructure like parks and roads, which lacks private substitutes. Panel data from 1995–2008 reveal how the distribution of income affects public investment. Revenue is endogenous to investment outcomes, and the analysis addresses this problem by exploiting a 1998, nationwide education finance reform and several revisions to the policy. The author constructs a variable that captures exogenous variation in revenue generated by nonlinearities of the law to instrument for observed revenue. Municipalities with higher median income and more inequality are less likely to allocate revenue to education or to expand pre-primary enrollment. They are more likely to allocate revenue to public infrastructure. There is suggestive evidence that this occurs for two reasons, hypothesized in two separate literatures. In rich and unequal municipalities, fewer total people support public education spending (the collective choice channel), and also, any given poor person wanting public education has less influence over policymakers there (the political power channel).

This paper is a product of the Human Development Department, Latin America and the Caribbean Region. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org.
The author may be contacted at kosec_katrina@gsb.stanford.edu.

Politics and Preschool: The Political Economy of Investment in Pre-Primary Education

Katrina Kosec*

JEL Keywords: Education Policy, Local Government Expenditures, Fiscal Federalism, Municipalities, Political Economy

*Stanford University, Graduate School of Business. This research began when the author was working in the Human Development Sector Management Unit of the Latin America and the Caribbean Regional Office at the World Bank, with support from the Brazil Country Management Unit; special thanks are owed to Barbara Bruns, Tito Cordella, Makhtar Diop, and David Evans. This research was also supported by a National Science Foundation Graduate Research Fellowship and a Stanford Institute for Economic Policy Research Dissertation Fellowship. The author is grateful to her dissertation committee for excellent advising: Caroline Hoxby, Seema Jayachandran, Saumitra Jha, and Romain Wacziarg. The author also thanks Michael Boskin, Sara Champion, Maria Fitzpatrick, Alex Frankel, David Laitin, Karthik Muralidharan, Kathryn Shaw, Ken Shotts, Fabián Valencia, Emiliana Vegas, Scott Wallsten, and Joel Wiles for helpful comments, and Érica Amorim, Leonardo Bursztyn, Flavio Cunha, Fernanda Estevan, Claudio Ferraz, Pedro Maciel, Guilherme Lichand, David Plank, Joseph Sands, Pedro Silva, and Brian Wampler for data and useful discussions about public policy in Brazil. All remaining errors are her own. Comments or suggestions are welcome and may be sent to kosec_katrina@gsb.stanford.edu.

1 Introduction

What drives governments with similar revenues to publicly provide very different amounts of goods for which private substitutes are available? Education and health-care are prime examples; in almost all countries, the public and the private sectors simultaneously provide versions of each. Access to them may have profound impacts on growth and welfare. It is important to understand why some governments provide more of the public version while others rely more on the private version. This is especially so since the rich and the poor often consume different versions, with the poor frequently consuming the public version. In this paper, I demonstrate that, in areas with higher median income and greater income inequality, governments allocate less of an exogenous revenue increase to goods with private substitutes (specifically, pre-primary education) and more to goods that have no private substitutes (such as roads and parks).

My central result can be explained by either of two existing theories. The first, "collective choice," hypothesizes that societies with higher income and more unequal income simply have more people who consume a private sector version of publicly-provided goods. Because they are consuming private versions, they vote for low spending on the public sector counterparts. Under majority voting, the government thus provides less of goods with private substitutes. This is in contrast to government provision of goods like infrastructure, which have no private substitutes. Important models in this vein are due to Barzel (1973), Besley and Coate (1991), Epple and Romano (1996), Glomm and Ravikumar (1998), de la Croix and Doepke (2009), and Gutirrez and Tanaka (2009). The second theory, "political power," argues that people have control over public policy that is roughly proportionate to their share of income, as opposed to their share of votes. That is, they can buy political influence, even in a democracy. As others grow richer relative to a given person, his ability to make government publicly supply the goods he wants (which might include pre-primary education) declines. This person might have more power under some sets of institutions that even the playing field. Prominent studies in this vein include Pande (2003), Foster and Rosenzweig (2004), Bardhan and Mookerjee (2006), Banerjee and Somanathan (2007), and Bartels (2009). The existing literature says little about the relative importance of the two theories (channels). This is problematic because they do not necessarily

imply the same socially-optimal policy interventions to address low equilibrium provision.

This paper's main contribution is an analysis of how an area's income distribution affects how its government allocates revenue between goods with and without private substitutes. I focus on pre-primary education in Brazil, for which private substitutes are readily available. The strength of my analysis derives from a change in Brazil's school finance law which generates exogenous variation that I carefully exploit. The paper's secondary contribution is an attempt to apportion the estimated effects between the two channels described above. To do this, I make use of the fact that some municipalities employ Participatory Budgeting (PB), an institution designed to ensure that the poor have policy influence equal to that of the rich. This exercise, although imperfect as PB is not randomly assigned, suggests that both theories are operative.

I focus on pre-primary education in Brazil for four main reasons. First, this is a service for which public and private versions are both widely available. Not only are private crèches and preschools abundant in Brazil, but also a family that cares for a young child at home is using a private version. Second, Brazil has over 5,000 municipalities with full discretion over how much revenue to allocate to pre-primary education. This is in contrast to health care and other levels of education, where central governments often set spending, access, and quality requirements for all areas.[1] Third, Brazilian municipalities differ greatly in their income distributions, and only some use PB. Otherwise, however, they have common institutional structures and constraints. Fourth, pre-primary education is interesting in and of itself. Currie and Thomas (1995), Currie (2001), Engle (2007), Berlinski *et al.* (2009), and Chetty *et al.* (2010) describe substantial benefits of investment in pre-primary, especially for poor children. Carneiro *et al.* (2003), Cunha *et al.* (2006), and Heckman and Masterov (2007) suggest that the return to investment in a person's human capital is higher the earlier it is made in his life. These researchers argue that, precisely because their parents cannot privately provide adequate substitutes, poor children enjoy *very high* returns to publicly-provided pre-primary. (This conclusion is not altogether uncontroversial.)

[1] Central governments often require universal provision of primary and secondary education, and impose quality criteria. For example, in the U.S., school districts must comply with state certification and education standards for teachers. Some states impose maximum teacher-student ratios, or school facility adequacy requirements (like square feet per pupil). See Epple and Romano (1996) for a demonstration of how a minimum provision requirement can cause enrollment that would be below the minimum level in equilibrium to jump far above it.

An analysis like mine faces a significant challenge to identification. Unobserved variables that cause municipalities to have different revenue levels may also cause them to have different preferences over goods. Fortunately, I am able to exploit a 1998 change in Brazil's education finance law that generates exogenous variation in municipalities' revenue. Specifically, I form a simulated instrumental variable that encapsulates the credibly exogenous variation in revenue generated by the law, but *excludes* variation due to the municipalities' own actions. I instrument for actual (endogenous) revenue with the simulated instrument, thereby testing how different municipalities differentially spend an exogenous shock to revenue, all else equal.

Briefly, the law, "Fund for Development of Elementary Education and Teachers" (FUNDEF) forced each of Brazil's 26 states to gather 15% of its municipalities' revenue in a state fund. Each municipality then received a share of the fund equal to its share of total public primary school students in the state. Because redistribution took place only *within* states (and also because of various nonlinearities in the spending rules), similar municipalities experienced very different changes in their finances. I form a simulated instrument using changes in the law's parameters applied to municipalities' pre-law school enrollment and finances. Thus, only the law-induced changes, not municipalities' responses, are incorporated in the simulated instrument.

The main results of the paper are as follows. An exogenous revenue increase attributable to the law change causes municipalities to spend more on education and to increase public pre-primary enrollment. However, richer and more unequal municipalities are significantly less likely to expand education spending and public pre-primary enrollment. The funds they do not spend on education are significantly more likely to end up in public infrastructure like roads and parks, which do not have private sector substitutes.

Having shown this main result, I attempt to determine which theory accounts for the effects of the distribution of income—the collective choice channel or the political power channel. To do so, I compute separate estimates for municipalities with and without PB. Under PB, a share of a municipality's revenue is automatically designated for each neighborhood, and neighborhood citizens vote on how to spend their share. (Thus, it would be hard for the rich to capture most of a municipality's revenue unless they somehow live in all neighborhoods, and dominate

policymaking.) Also, under PB, the government is forced to publicize its budgets and spending in a transparent manner. Case studies from Brazil suggest that PB increases political participation of otherwise marginalized people and increases government accountability (Souza 2001).

To the extent that PB reduces the ability of the rich to buy disproportionate political influence, its presence suppresses the political power channel. Thus, the remaining effects are likely due to the collective choice channel. My estimates suggest that the political power channel accounts for about 30% of the effects, so that the collective choice channel is left with about 70%. In other words, both channels play an important role in determining how an area's income distribution affects public investment. (The PB estimates should be interpreted with care since PB is not randomly imposed. Even though municipalities with very similar income distributions differ in whether they use PB, the ones that use it are presumably enthusiastic about transparency and ensuring that the poor have a political voice. It is not obvious that PB would have equally large effects in municipalities that do not wish to have it in place.)

The remainder of the paper is organized as follows. Section 2 puts this paper in context by reviewing closely related studies. Section 3 describes pre-primary education, the political system, and education finance in Brazil, with special attention to the 1998 FUNDEF law and subsequent revisions to it. Section 4 presents a formal model of the collective choice channel and sketches the model that appears to be in the minds of most researchers interested in the political power channel. Section 5 outlines the empirical strategy and data sources. Section 6 presents the main empirical results. Section 7 shows a variety of robustness checks. Section 8 concludes.

2 Context

Two literatures could explain my results. Each describes a channel through which the distribution of income affects public investment. It is an empirical question whether they operate simultaneously. For now, one should consider them both to be possible explanations. Later, I work to apportion their combined effects between the two channels.

The first is a theoretical literature describing a "collective choice" channel. Authors use a variety of approaches, but their models are embedded in a similar logic, and generate similar

predictions. They hypothesize that if education quality is a normal good, the existence of private education leads parents past a threshold income to exit the public sector. This is the income at which the cost of private school tuition is just offset by the utility gain from consuming higher-quality education. In societies with higher income and more unequal income, more people use private schools, and thus vote for low or no spending on public education. Under majority voting, this means less public education. Stiglitz (1974) showed that preferences are not singled-peaked when private education is available. Several approaches address this and obtain existence of a majority voting equilibrium: imposing a single crossing property in a median voter model (Epple and Romano, 1996; Gutirrez and Tanaka, 2009), identifying the decisive voter (Barzel, 1973; Glomm and Ravikumar, 1998), and using a probabilistic voting model (de la Croix and Doepke 2009). In the next section, I present a model similar to de la Croix and Doepke (2009). However, the reader should be aware that a variety of modeling assumptions deliver similar results.

The second literature describes a "political power" channel. It finds that the rich exercise control over public policy that is roughly proportionate to their share of income (or a function of it), as opposed to their share of votes. Chambers (1983) argues that the inability to influence policy is a defining feature of relative poverty. A number of papers show that inequality reduces the political influence of the poor. It is less clear what is the effect of higher median income. However, the *key* implication of papers in this literature is that the distribution of income *affects* policy, by affecting the distribution of political power and influence.

Several prominent empirical studies describe the political power channel. Foster and Rosenzweig (2004) use panel data on villages in rural India to show how the share of the population made up of landless poor affects public investment when the village leader is or is not elected. They find that in democratic villages, an increase in the share of landless increases road investment (which the landless want) and decreases irrigation investment (which they do not want) more than in non-democratic villages.[2] Bardhan and Mookerjee (2006), using a longitudinal

[2]Several studies find similar results. Bates (1973, 1976, 1981) shows that some ethnic groups in post-independence Africa increased their access to public funds by increasing their political salience. Varshney (1995), Jaffrelot (2003), Pande (2003), Chandra (2004), and Banerjee and Somanathan (2007) find similar results for low caste groups in India. And Mansuri and Rao (2004) demonstrate, in a review of World Bank community-driven development projects, that most projects are dominated by local elites and do not target the poor.

sample of West Bengali villages, find that villages with high land inequality and large incidence of low-caste status and poverty receive less money from the central government. Within villages, these factors do *not* affect who obtains government transfers (of credit, seeds, fertilizer, etc), but *do* affect the allocation of public goods (whose allocation is less transparent), and the propensity to select projects that generate employment for the poor. Bartels (2009) shows that U.S. voters are not political equals. Inequality drives a wedge between what poor and rich citizens can spend to influence policy. In an empirical analysis of senator voting patterns in the 1980s and 1990s, he finds that the upper third of the income distribution had 50% more influence than the middle third, and the bottom third had none.[3] In a review of the literature, Keefer and Khemani (2005) attribute such findings to political market imperfections that reduce the incentives of politicians to provide broad public goods and reduce poverty. [4] The authors note that "the broad services most important to the poor—health and education—are the most vulnerable to these three distortions." To prevent domination of public policy by the rich (elite capture), they describe the potential of decentralization, legislative reservations, and participatory budgeting.[5]

3 Background

3.1 Access to pre-primary education in Brazil

Policymakers in many parts of the world have extended public education to the pre-primary level, covering children ages 0-6. A huge body of new research suggests that this investment may benefit children (especially disadvantaged ones), parents (especially mothers), and society.[6] Patrinos (2007) estimates a preschool benefit-cost ratio of 2.0 for Brazil, which is larger than

[3]According to Bartels, several trends are tightening the connection between income and influence: increasing political campaign expenditures and lobbying activities by corporations, and declining labor union membership.

[4]These include information gaps, social fragmentation, identity-based voting, and the inability to make credible promises. They may undermine the model of Meltzer and Richard (1981), who predict that government redistribution increases in inequality. Knack and Keefer (1997) find no evidence to support Meltzer and Richard.

[5]Despite a lack of formal political power, other work suggests that the poor may have indirect power. Jha *et al.* (2007) describe how informal slum leaders in India (*pradhans*) play a key role as intermediaries between the urban poor and the government, allowing the poor access to services. Rock (1972), Auyero (2001), and Kingstone and Power (2008) describe how neighborhood bosses aggregate and voice communal interests in Latin America.

[6]See Currie and Thomas (1995), Currie (2001), Jaramillo and Tietjen (2001), Campbell *et al.* (2002), Love *et al.* (2002), Schweinhart *et al.* (2005), Aboud (2006), Armecin *et al.* (2006), Knudson *et al.* (2006), Engle *et al.* (2007), Berlinski *et al.* (2008), Fitzpatrick (2008), Berlinski *et al.* (2009), Cascio (2009), and Chetty *et al.* (2010).

that of most public industrial and agricultural investments. Other research interprets beneficial findings with caution.[7]

It is inherently difficult to explain investment in public pre-primary. Investing requires revenue, which is less abundant in poor areas. However, poor areas may have higher net benefits from public pre-primary, making them more likely to invest. This may explain why economic development is not a good predictor of pre-primary enrollment. Many European countries have among the highest public preschool enrollment rates, but Brazil, Ecuador, Mexico, and Thailand have higher rates than either the U.S. or the U.K. (UNESCO 2006).[8]

Formal, school-based pre-primary education in Brazil has expanded rapidly but unevenly in recent years. Figure 1 shows the national enrollment rate during 1995-2008.[9] Enrollment expanded from 8% to 18% among 0-3 year-olds (crèche age) and from 48% to 80% among 4-6 year-olds (preschool age). The Figure 2 maps show 2008 state-level averages. In 2008, crèche enrollment ranged from 6% to 32%, and preschool enrollment ranged from 57% to 91%.[10]

Private pre-primary education in Brazil is of higher quality than public pre-primary. Table 1 presents 2008 means of several school-level variables including pre-primary students per teacher, the fraction of pre-primary teachers with at least some post-secondary education,[11] and the fraction of pre-primary schools with a designated school building,[12] electricity, an indoor bathroom, a library, and a computer. Private pre-primary schools outperform public on each measure of quality, and the difference is statistically significant at the 0.01 level. Some of the differences are large. Public institutions have 3 more children per teacher, and 15% fewer teachers with post-secondary training, than private institutions. Indoor bathrooms are present in 80% of

[7]Anderson (2008) notes that some of the most influential randomized evaluations carried out in the U.S.—the Abecedarian Project, the Perry Preschool Program, and the Early Training Project—have serious statistical inference problems and confounds. DHHS (2010) finds that advantages gained during a year of the Head Start preschool program at age four dissipated by 2nd grade. Gormley *et al.* (2010) find that pre-K quality is key.

[8]There is also substantial within-country variation. For example, in the U.S., while Florida, Georgia, and Oklahoma provide free preschool to all four year-olds, 12 states do not fund any pre-primary (Pre-K Now 2010).

[9]In 2007, school became mandatory for six year olds, when primary education expanded from an eight to a nine year sequence. This explains the sharp spike in the ages 4-6 graph in 2007, as parents of six-year-olds no longer had the option to keep their children out of formal schooling.

[10]Averages are based on parental self reports in the National Household Sample Survey (PNAD). For a detailed discussion of heterogenous trends in access to pre-primary in Brazil during 1996-2008, see Evans and Kosec (2010).

[11]This includes any post-high school education, whether or not a degree was obtained.

[12]Some schools report using a teacher's house, church, community center, local business, barn, or shed.

public schools, but 96% of private ones. A library is present in 20% of public schools, but 62% of private ones. This suggests why parents may pay for private pre-primary when public is free.

In the 2000 Census, about 32.8% of Brazilians were below the indigence line, defined as the income necessary to consume the FAO minimum daily caloric intake.[13] Based on the most recent household expenditure survey conducted in Brazil,[14] median *per child* expenditure on private pre-primary education was 74% of the indigence line income. The 5th percentile of *per child* expenditure was 15% of the indigence line income. This suggests that the indigent (and probably many above this line) could not afford formal, private pre-primary education.

At higher incomes, parents are less likely to send their child to public pre-primary school, less likely to keep their child out of school, and more likely to send their child to private pre-primary school than at lower incomes. Figure 3 illustrates this with child-level data from the 2000 Brazilian Census. I examine the school enrollment status of 4-6 year-olds (preschool children), and observe how this varies with per capita household income. From all enrollment and income variables, I net out the effects of many potentially-relevant demographic characteristics.[15] I then plot the residuals and fit a quadratic function. The function is positively-sloped when I consider a dummy for enrollment in private pre-primary, or a dummy for enrollment in any pre-primary. It is negatively-sloped when I consider a dummy for enrollment in public pre-primary. This will be important later, as it supports my assumption that private pre-primary is a normal good.

3.2 Municipal governments and their finances

Brazil has over 5,000 municipal governments, with remarkable financial and political autonomy. They are led by an elected mayor and an elected city council. Legislative, budgetary, and administrative authority are concentrated in the mayor's office, and the city council is largely responsible for approving the mayor's policies (Couto and Abrucio 1995; Wampler 2007).[16]

[13] This is 2,288 calories. See Ferreira *et al.* (2003) for computations of three poverty lines for Brazil using 1996 household survey data. The lowest is the indigence line. The authors also present a set of spatial income deflators.

[14] This is the 1996-97 Living Standards Measurement Survey, carried out by the Brazilian Institute of Geography and Statistics (in Portuguese, Instituto Brasileiro de Geografia e Estatística (IBGE)).

[15] I partial out the effects of child age and gender, household size, municipality fixed effects, and several household head variables including gender, migration status, years of education dummies, race dummies, and age dummies.

[16] For a thorough discussion of local politics in Brazil, see Ames (2001) and Kingstone and Power (2008). For a treatment specific to the politics of education, see Plank (1996).

The federal, state, and municipal governments share responsibility for publicly-provided goods. Municipalities provide pre-primary and primary education, within-city transportation, and infrastructure and urban development. The municipal revenue base is comprised of state and federal government transfers, municipal tax collection, and miscellaneous revenue (e.g., earnings from industrial, agricultural, and mineral activities). See Appendix B for more detail.

Education is one of the few publicly-provided goods with private substitutes that municipal governments supply. They provide two levels: pre-primary (ages 0-6) and primary (ages 7-14), with higher levels handled by state and federal governments. Primary education must be available to all children at a federally-regulated minimum expenditure per student, and attendance is compulsory. Pre-primary is optional for governments and for parents. Municipalities must spend at least 25% of revenue on education. Municipal governments provide most public primary education (83% of students in 2007), but state governments have some primary schools.

3.3 The FUNDEF and FUNDEB education finance reforms

Brazil has a history of cross-state and cross-municipality income inequality.[17] This has translated into high variance in per capita municipal revenue. In 1998, the federal government passed an education finance reform to partially equalize funding across municipalities: "Fund for the Development of Elementary Education and Teachers" (FUNDEF).[18] Federal policymakers worried that disparities in basic education investment threatened national progress.[19] Rich states opposed nation-wide redistribution, so a compromise of within-state redistribution was reached.

FUNDEF obligated each of Brazil's 26 states to gather 15% of each municipality's revenue, and 15% of state government revenue, in a state fund.[20] Each municipality then received a share of the fund equal to its share of total public primary school students in the state. Enrollment

[17] In 2007, Brazil's GDP per capita was 13,400 (constant 2005 R$). (The average 2005 exchange rate was 0.4 USD/Reais). It ranged from 4,300 R$ in Piauí state to 37,700 R$ in the Federal District (IBGE 2007).

[18] In Portuguese, Fundo de Manutenção e Desenvolvimento do Ensino Fundamental e de Valorização do Magistério.

[19] For a detailed account of Brazilian education policy during 1995-2002 from former Minister of Education Paulo Renato Souza, who implemented FUNDEF, see Souza (2005).

[20] More accurately, each municipality had to pay into the fund 15% of its revenue from each of four main intergovernmental transfers, which usually comprise the vast majority of municipal revenue.

data come from the Ministry of Education's annual Census of Schools (Censo Escolar).[21]

The 15% payment to the state fund *did* count toward the 25% minimum expenditure on education, but 10% more was required. All fund receipts had to go to education. If receipts did not reach a federal minimum per primary school child, the federal government would 'top off' the fund, bringing it to this level.[22] This ensured universal primary education of the required quality before municipalities spent the remaining 2/5 of mandated education spending. In 2007, the policy continued under "Fund for the Development and Maintenance of Basic Education" (FUNDEB),[23] which gradually increased the fraction of revenue paid to the fund and added other levels of education to the redistribution algorithm. See Appendix B for more detail.

Municipalities benefitting from the reform looked poor compared to others in their state (even if they were rich in the Brazil-wide sense). In 1998, the average municipality got back 1.1 times what it paid in. At the 25th percentile of net receipts, municipalities got back 1/3 of the amount paid in. At the 75th percentile, they got back 1.6 times the amount paid in. For a municipality paying 15% of revenue, this implied a loss equivalent to 10% of revenue at the 25th percentile, and a gain equivalent to 9% of revenue at the 75th percentile. These are large effects that likely led them to re-optimize spending. Table 2 summarizes the frequency of high, moderate, and low net FUNDEF receipts per child in 1998 by high, moderate, and low average income per capita. Many rich municipalities gained a lot, and many poor ones lost a lot.

A few factors limited FUNDEF crowd-out of local money. First, all fund receipts had to go to education (by law). Beneficiaries could potentially use fund receipts for other purposes by reducing *voluntary* (above 25% of revenue) education spending. However, 37% of municipalities had *zero* voluntary education spending in 1997 (the minimum was binding), and it was close to binding for many more. If these municipalities cut taxes in response to new money, they would have to reduce non-education spending, which might not be possible. Second, many

[21]The National Institute of Educational Studies and Research (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira) (INEP), an agency under the Ministry of Education, conducts the survey. State and municipal departments of education collect the data, with public and private school cooperation. The transfer of public funds depends on schools' cooperation with the survey, making the public school data especially reliable.

[22]In 1998, six states got federal top-off: Bahia, Ceará, Maranhão, Pará, Pernambuco, and Piauí. The per-child minimum changed annually. It began to vary with child age (in 2000) and school type (rural/ urban) (in 2005).

[23]In Portuguese, Fundo de Manutenção e Desenvolvimento da Educação Básica.

municipalities depended heavily on transfers for revenue, reducing their power to choose the level of revenue (in 1997, the average municipality got 85% of revenue from transfers). Finally, politicians may not have wanted to cripple local tax collection infrastructure by lowering or eliminating taxes, in case FUNDEF were short-lived or its effects changed over time. As a result, revenue changed significantly with the new law. Table 3 shows a frequency cross-tabulation of municipalities in 1997 at each of five levels of education spending and five levels of dependence on transfers. Panel (A) includes all municipalities, and Panel (B) includes predicted beneficiaries. In both panels, about 56% of municipalities spend only 25% of revenue on education, get 95-100% of revenue from transfers, or both. Most would be highly constrained in their offsetting behavior.

4 Theoretical Framework

In this section, I present a formal model of the collective choice channel. It closely follows de la Croix and Doepke (2009), and has similar comparative statics: an increase in inequality or in mean or median income leads to lower public school enrollment, less public education expenditure, but higher-quality public education. My model differs in two respects. First, I exogenize public revenue. Interventions like education finance equalization and aid do something similar. I assume that policymakers allocate exogenously-given revenue between a good with private substitutes (education) and one without (infrastructure). Second, for simplicity, I eliminate endogenous fertility and assume each family has one voting parent and one child.

The distribution of income may also affect public investment through the political power channel. In the formal model that follows, I suppose that citizens' policy preferences—which vary with income—are aggregated in an unbiased way, via majority voting. I show why median income and inequality affect policy when all citizens have equal influence. I next sketch the model that appears to be in the minds of most researchers interested in the political power channel.

4.1 Preferences

A municipality is populated by a continuum of households of measure 1. Households each include one parent and one child, and are differentiated by their income x. Parents derive utility from

consumption c, their children's education h, and expenditure on public infrastructure f:

$$u = \ln(c) + \gamma \ln(h) + \eta \ln(f) \tag{1}$$

$\gamma \in \mathbb{R}_+$ is the weight attached to children's education, and $\eta \in \mathbb{R}_+$ is the weight attached to infrastructure. Education is a dual-provision regime good, meaning it can be obtained in the public or the private sector. Infrastructure—which may include roads, parks, or transportation systems—can only be obtained from the public sector. Publicly-provided goods are financed with exogenous public sector revenue y. Education is funded by paying teachers a wage, normalized to 1. Public education provides a uniform education of quality s, and is free to parents. Parents can also opt out of the public education system and freely choose the private education quality e they desire, but they must pay the teacher from their own income. Parents vote over the fraction T of revenue y that will be used to fund public education, which determines the public schooling quality s. Remaining public funds are invested in infrastructure. The budget constraint for a parent is given by:

$$c = x - e \tag{2}$$

where $e = 0$ if the parent chooses public education. Education is expressed as h=max $\{e, s\}$. Substituting in the household budget constraint allows me to write household utility as:

$$u[x, T, e, s] = \ln(x - e) + \gamma \ln \max\{e, s\} + \eta \ln((1 - T)y) \tag{3}$$

4.2 Timing of events and private choices

Parental preferences over T depend on income x and the education choice e. The education choice is made before voting takes place.[24] Parents providing private education choose:

$$e[x] = \underset{e}{\text{argmax}} \; u[x, T, e, s] = \frac{\gamma}{1 + \gamma} x \tag{4}$$

As education quality is a normal good, private spending is increasing in income x. Parents have expectations about public education quality, $E[s]$, which determine their education choice.

[24]This assumption is natural given switching costs between public and private school. As shown below, e does not depend on the outcome of the voting process. Thus, the timing of its choice does not affect the results.

Lemma (Opting-out decision). *There exists an income threshold:*

$$\tilde{x} = \frac{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}{\gamma} E[s] \tag{5}$$

such that households strictly prefer private education if and only if $x > \tilde{x}$.

Proof. See Appendix C. ■

An implication of this lemma is that, if parents with income x choose public schooling, all those with income $x' < x$ strictly prefer public schooling. Also, if parents with income x choose private schooling, all those with income $x' > x$ strictly prefer private schooling.

I assume a uniform distribution of income over the interval $[1+r-\sigma, 1+r+\sigma]$.[25] Average (and median) income equals that of teachers when $r = 0$. The parameter $\sigma \in (0, 1+r)$ captures the degree of income inequality, and r captures how rich the average citizen is. The associated density function is given by $g(x) = 0$ for $x < 1+r-\sigma$ and for $x > 1+r+\sigma$, and $g(x) = 1/(2\sigma)$ for $1+r-\sigma \leq x \leq 1+r+\sigma$. The fraction of children in the public education system is given by:

$$\Psi = \begin{cases} 0 & \text{if } \tilde{x} < 1+r-\sigma \\ \frac{\tilde{x}-(1+r-\sigma)}{2\sigma} & \text{if } 1+r-\sigma \leq \tilde{x} \leq 1+r+\sigma \\ 1 & \text{if } \tilde{x} > 1+r+\sigma \end{cases} \tag{6}$$

4.3 Preference aggregation and equilibrium

The municipal government operates under a balanced budget rule:

$$f + \int_0^{\tilde{x}} s\, g[x]\, dx = y \;\Leftrightarrow\; f + \Psi s = y \tag{7}$$

where total public infrastructure investment is $f = (1-T)y$ and total public education investment is $\Psi s = yT$. T is chosen via probabilistic voting, which I describe in detail in Appendix C. Since s and T are linked through the budget constraint, the policy choice is one-dimensional.

The intuition of probabilistic voting is as follows. Under probabilistic voting, one assumes that there are two political parties, p and q. The median voter model assumes that the probability

[25] de la Croix and Doepke (2009) also assume a uniform distribution, for simplicity. Other distributions yield similar results. Under probabilistic voting, there is no significance to the relative positions of median and mean.

that a voter casts a ballot for party q jumps discretely from 0 to 1 once the voter's utility gain from party q winning instead of p becomes positive.[26] Probabilistic voting assumes that voters may be more ideologically drawn to one party than the other, independently of the party's proposed policy. The probability of voting for party q increases gradually as party q's platform becomes more attractive, and each party's vote share thus varies continuously with the proposed policy platform. This leads to smooth aggregation of all voters' preferences instead of sole dependence on the preferences of the median voter. Both parties maximize their vote share by maximizing a weighted social welfare function, where weights are decreasing in a voter's ideological bias. The parties act symmetrically in equilibrium, both trying to maximize their vote share, so $T = T^p = T^q$ and $s = s^p = s^q$. For simplicity, I assume all voters have the same level of ideological bias. In this case, the objective function maximized by the policymaker under the probabilistic voting mechanism is given by:

$$\Omega[s] \equiv \int_0^{\tilde{x}} u[x, T, 0, s]\, g[x]\, dx + \int_{\tilde{x}}^{\infty} u[x, T, e[x], 0]\, g[x]\, dx \tag{8}$$

which is maximized subject to equation (7). The policymaker's maximization problem yields:

$$s = \frac{y\gamma}{\eta + \gamma\Psi} \tag{9}$$

$$T = \frac{\gamma\Psi}{\eta + \gamma\Psi} \tag{10}$$

Equation (9) shows that s is decreasing in the participation rate in public schools, Ψ. When more children participate in public schools, spending per child is reduced. From equation (10), a rise in participation is followed by a less than proportional rise in the fraction of public spending going to education. Appendix C presents a proof of the existence and uniqueness of an equilibrium.

4.4 Comparative statics

Proposition 1 (Revenue and public education). *An exogenous revenue increase leads to higher enrollment in public school. It may lead to a higher or a lower quality of public school:*

$$\frac{\partial\Psi}{\partial y} \geq 0, \qquad \frac{\partial s}{\partial y} \lesseqgtr ?\ 0$$

[26] This voting mechanism delivers an equilibrium despite the existence of non-single-peaked preferences over T.

A revenue increase leads to more public spending on education, which entices more parents to use public school. Quality will depend on whether new enrollment offsets new expenditure.

Proposition 2 (Inequality and public education).[27] *If $\Psi \geq 0.5$, an increase in inequality leads to lower enrollment in public school, a higher quality of public school, and a smaller fraction of revenue going to public school:*

$$\frac{\partial \Psi}{\partial \sigma} \leq 0, \quad \frac{\partial s}{\partial \sigma} \geq 0, \quad \frac{\partial T}{\partial \sigma} \leq 0$$

Proposition 3 (Income and public education). *An increase in mean or median income leads to lower enrollment in public school, a higher quality of public school, and a smaller fraction of revenue going to public school:*

$$\frac{\partial \Psi}{\partial r} \leq 0, \quad \frac{\partial s}{\partial r} \geq 0, \quad \frac{\partial T}{\partial r} \leq 0$$

Proof of Propositions 1, 2, and 3. See Appendix C. ■

Intuitively, an increase in income or inequality raises the income of the marginal person, who was previously indifferent. The person now strictly prefers private school, leading to lower enrollment in public. Enrollment drops more quickly than spending, so public school quality increases.

This model permits the distribution of income to affect public investment only through its effect on the collective choice. In contrast, a sizeable literature suggests that the distribution of income affects policy through its effect on citizens' relative power and influence over policymakers. Theoretical models describing political power mechanisms model political participation increasing in income (Benabou 2000), political power depending on how active are the media (Besley and Burgess 2002), and special-interest groups being able to make political contributions in order to influence policy (Grossman and Helpman 1994). Empirical papers on the political power channel (reviewed in Section 2) are naturally less explicit about the particular function translating income into political power. However, most authors seem to have in mind a model in which influence is

[27] A focus on regions of the parameter space where $\Psi \geq 0.5$ is common to most of the public finance literature on the public provision of education in a dual-provision regime. Since participation in public schools far exceeds 50% in nearly all countries, the literature notes that this is the empirically relevant case.

an increasing function of income. The rich can offer larger campaign contributions or bribes, and may have lower costs of political activity due to personal connections with politicians. Several papers show that inequality reduces the influence of the poor. The effect of higher median income in less clear.[28] However, a *key* implication of papers in this literature is that the distribution of income *affects* policy, by affecting the distribution of political power.

It seems reasonable that both channels matter, but their effects have not been separated by the existing literature. In the next section, I show how median income and inequality affect investment. I then attempt to apportion the estimated effects between the two channels.

5 Empirical Strategy

Theory suggests that higher median income and higher inequality lead to: (i) lower enrollment in public school, (ii) higher public education quality, (iii) lower public education expenditure, and (iv) higher public expenditure on goods without private substitutes, like infrastructure. Here, I present an empirical model that captures these theoretical predictions. I test the model using panel data on Brazil's over 5,000 municipalities during 1995-2008. Shortly, I take up the issues of identification and measurement of income, inequality, enrollment, and school quality. For now, assume that these variables are accurately measured and all variation in revenue is exogenous.

The availability of revenue affects investment. Ideally, one would randomly assign per capita revenue, r_{it} to municipalities with varying distributions of income, and see how the distribution of income moderates how revenue is spent. This experiment implies the following empirical specifications:

$$p_{it} = \alpha_{1,i} + \beta_{1,t} + \gamma_1 r_{it} + \delta_1(r_{it} \times g_i) + \theta_1(r_{it} \times d_{it}) + \eta_1 d_{it} + u_{1,it} \tag{11}$$

$$q_{it} = \alpha_{2,i} + \beta_{2,t} + \gamma_2 r_{it} + \delta_2(r_{it} \times g_i) + \theta_2(r_{it} \times d_t) + \eta_2 d_{it} + u_{2,it} \tag{12}$$

$$e_{it} = \alpha_{3,i} + \beta_{3,t} + \gamma_3 r_{it} + \delta_3(r_{it} \times g_i) + \theta_3(r_{it} \times d_{it}) + \eta_3 d_{it} + u_{3,it} \tag{13}$$

[28] A variance-preserving, mean-increasing shift in the distribution of income would have different effects, for example, if the function converting income into influence is linear vs. exponential.

$$f_{it} = \alpha_{4,i} + \beta_{4,t} + \gamma_4 r_{it} + \delta_4(r_{it} \times g_i) + \theta_4(r_{it} \times d_{it}) + \eta_4 d_{it} + u_{4,it} \tag{14}$$

where i index municipalities and t index years. Capturing the distribution of income, d_{it} is (median or mean) per capita income and g_{it} measures the inequality of its distribution. I care about enrollment in and quality of public pre-primary education, described by p_{it} and q_{it}, respectively. I also care about how much revenue policymakers spend on public education, e_{it} vs. on goods only obtainable from the public sector (like roads and parks), f_{it}. I consider both total per capita spending and the fraction of revenue spent on each category.

National inequality in Brazil has changed little in the last 50 years.[29] To avoid overstating the significance of subtle variation in inequality, and given a lack of inequality data for intercensal years, I assume that within-municipality income inequality is roughly constant over the sample period. Thus, it only enters the model in interaction.

The predictions that more unequal and higher-income municipalities are less likely to use revenue to expand public pre-primary enrollment, and more likely to increase its quality, implies:

$$\theta_1, \delta_1 < 0, \quad \theta_2, \delta_2 > 0$$

The predictions that more unequal and higher-income municipalities spend relatively less revenue on education, and more on goods without private substitutes (infrastructure), implies:

$$\theta_3, \delta_3 < 0, \quad \theta_4, \delta_4 > 0$$

5.1 Identification

There are two identification problems likely to affect the analysis of pre-primary education policy. The first is the potential for omitted variable bias. The second is the potential for observed per capita revenue to be endogenous due to reverse causality.

Observed per capita revenue is the result of factors affecting both the supply of funds and the population's demand for funds. I want to rely solely on variation in revenue that comes from the supply side. Factors which affect demand for revenue may have a direct effect on pre-

[29] In 1960, the first year the Brazilian Census collected household income data, the national Gini coefficient was 0.59. It was also 0.59 as of the 2000 Census (Skidmore 2004).

primary education policy choices. If they do, then naïve estimates of the effects of revenue and its interactions with income and inequality would be biased by omitted variables.

There are several possible sources of omitted variable bias (I detail three below). First, having an older population may mean more working adults as a fraction of the population, and thus more tax revenue. However, if having fewer children reduces the need for pre-primary education, ordinary least-squares (OLS) estimates of the effects of revenue and its interactions with income and inequality would be biased. The magnitude of the bias would shrink as measures of population-by-age are added to equations (11), (12), (13), and (14), but it would be impossible to know when all bias had been eliminated. This would downward-bias estimates of the effects of revenue on pre-primary enrollment and quality, and education investment. Second, mayors with high discount rates or who are corrupt may generate higher revenue to maximize private gains.[30] However, short-sightedness may also lower investment in education, which has long-term payoffs. This, too, would downward-bias the estimates. Finally, municipalities with higher revenue may pay higher wages to public officials. Ferraz and Finan (2009b) show that, in Brazil, this leads to more political competition, and to the election of better-educated, more experienced, more productive candidates. If these qualities increase public pre-primary investment, this would upward-bias estimates of the effects of revenue on such investment.

Municipal revenue per capita can also be a response to education policy. This is a classic problem of reverse causality. Municipalities that invest heavily in pre-primary may need to level more taxes to pay for it. The best response to these identification problems is a set of valid instruments. These instruments should affect revenue and its interactions with per capita income and inequality, but should be uncorrelated with factors affecting the demand for revenue.

5.2 Instruments for per capita revenue

To address these threats to identification, I exploit the federal FUNDEF/B education finance reforms described in Section 3, which generated exogenous variation in municipalities' revenue.

[30] de Janvry *et al.* (2009) suggest such a possibility. They find that second term mayors in Brazilian municipalities, who are not eligible for reelection, have less transparent policies and are less likely to reduce school drop-out rates using federal funds designated for this purpose. Ferraz and Finan (2009a) show that first term mayors misappropriate 27% fewer resources than second term mayors, which they also link to electoral incentives.

These laws redistributed revenue within states according to an algorithm handed down by the federal government, and thus exogenous to any one municipality's investment decisions. The rules changed slightly each year, but always identify two things: how much each municipality has to pay into its state's education fund (always a set fraction of its revenue), and how much of the fund is given to each municipality (equal to its share of total public school students in the state, with students at different grade levels weighted differently each year). Given enrollment and initial revenue data for all municipalities, the algorithm delivers a "new" revenue to each municipality, which is lower for net losers and higher for net winners from the reform.

Of course, the reforms almost certainly induced endogenous revenue and enrollment responses (Hoxby 2001; Gordon 2004). A good instrument should encapsulate the credibly exogenous variation in revenue generated by the law, but *exclude* variation due to municipalities' own actions. To do this, I simulate the revenue each municipality would have each year if the current year algorithm were applied to 1997 (pre-reform) enrollment and revenue data. I then instrument for actual (endogenous) revenue with the simulated instrument, which allows me to test how different municipalities differentially spend an exogenous shock to revenue, all else equal. I instrument for the interaction of per capita revenue with covariates using the interaction of simulated per capita revenue with those covariates.[31] See Appendix D for further details.

The first stage equations state that per capita revenue and its interactions with per capita income and inequality are a function of simulated per capita revenue, s_{it} and its interactions with per capita income and inequality:

$$r_{it} = \rho_{1,i} + \kappa_{1,t} + \lambda s_{it} + \pi_1(s_{it} \times g_i) + \phi_1(s_{it} \times d_{it}) + \omega_1 d_{it} + \epsilon_{1,it} \tag{15}$$

$$r_{it} \times g_i = \rho_{2,i} + \kappa_{2,t} + \lambda s_{it} + \pi_2(s_{it} \times g_i) + \phi_2(s_{it} \times d_{it}) + \omega_2 d_{it} + \epsilon_{2,it} \tag{16}$$

$$r_{it} \times d_{it} = \rho_{3,i} + \kappa_{3,t} + \lambda s_{it} + \pi_3(s_{it} \times g_i) + \phi_3(s_{it} \times d_{it}) + \omega_3 d_{it} + \epsilon_{3,it} \tag{17}$$

[31] In a similar vein, Martínez-Fritscher *et al.* (2010) use commodity price shocks in Brazil during 1889-1930 as an instrument for state capacity to spend on publicly-provided goods. They find that education expenditures increased during this period in response to positive shocks to the prices of commodities produced heavily in a given state.

I must avoid introducing endogenous variation into the instruments. This might occur if municipalities are on different time trends according to their values of the pre-period variables used to compute the instruments. Municipalities might also be on different time trends according to initial public pre-primary enrollment levels. I address these concerns by including the interaction of a linear time trend, t with a vector of the 1997 values of per capita revenue, per capita transfer revenue, the fraction of public primary school students in state or federal schools, the fraction of 0-6 year-olds enrolled in public pre-primary, and public pre-primary enrollment squared. This allows for heterogeneous secular trends in municipalities with different pre-reform characteristics.

In the results section, I demonstrate that these instruments satisfy the inclusion restriction: they are correlated with observed per capita revenue and with its interactions with per capita income and inequality. The exclusion restriction should hold since the instruments depend only on pre-reform municipality characteristics (captured by fixed effects) and federal government rules, which are exogenous to any particular municipality's investment during the sample period.

5.3 Measuring income, inequality, and pre-primary investment

I measure income two ways, to ensure robustness: median and average per capita municipal income. I compute median per capita household income using 2000 Census data. Average income data are available annually. I measure inequality with the municipal Gini coefficient, computed from 2000 Census data. Results instead using mean over median income, and the level of income polarization,[32] are similar and available upon request. Table 4 presents a correlation matrix of these variables. The correlation between the Gini coefficient and per capita income (whether median or average), is always below 0.04 in absolute value. Median and average income have a correlation of 0.72.

I have panel data on several aspects of public pre-primary education quality:[33] pre-primary students per teacher, the fraction of pre-primary teachers with at least some post-secondary education, and the fraction of pre-primary schools with a designated school building, electricity, an

[32] I measure income polarization using individual-level data on all voting-age (16+) persons in the 2000 Brazilian Census, and following the method described in Duclos, Esteban, and Ray (2004). I set the parameter α, capturing the importance of local clustering of income, to an intermediate value of 0.5.

[33] All measures of pre-primary education quality are not available for 1995, but are available for 1996-2008.

indoor bathroom, a library, and a computer. Given high correlation among these variables, I use principal components analysis (PCA) to combine the first two measures into an index of teacher quality, and the last five into an index of infrastructure quality. I reduce the dimensionality of the data by using the first principal component. In the teacher quality PCA, the first principal component explains 52% of the variation in the quality variables, with an eigenvalue of 1.04. In the infrastructure quality PCA, it explains 60% of the variation, with an eigenvalue of 3.01.

The pre-primary enrollment rate is the number of public pre-primary school students (crèche or preschool) as a fraction of the population of children aged 0-6. Starting in 2007, the denominator is the population of children aged 0-5 (the new primary school age range).

5.4 Demographic, economic, and political trends

An additional concern is the potential correlation of income and inequality with demographic, economic, or political trends that affect public investment. I thus account for total population, age 0-6 population, and age 7-15 population (all in 100,000s) in the main specification. As a matter of robustness, I show specifications including three time-varying political factors: the mayor's vote share in the previous election, the number of political parties competing for mayor, and an HHI of between-party competition for mayor. I also show specifications including time-varying exogenous shocks to the world prices of three important agricultural products in Brazil: coffee, cocoa, and bananas. I multiply the current year world price of each by how many hectares there were in the municipality in 1994.[34] The inclusion of all three sets of variables has virtually no effect on the sign, magnitude, or significance of γ, δ, or θ in any of equations 11 through 14.

5.5 Data

I used several data sources, matched geographically at the municipality level. An observation is a municipality-year. Data are generally available for 1995-2008, and are summarized in Table 5.

School-level data on students, teachers, infrastructure, and amenities are available from INEP's Census of Schools. The data are of very high quality and detail. From these data, I computed school enrollment by level (pre-primary, primary, secondary) and administrative

[34]This Herfindahl-Hirschman Index (HHI) takes a municipality to be a market and political parties to be firms.

dependence (municipal, state, federal, or private), and computed the quality measures described earlier. Annual data on income per capita, population, and population-by-age are available from IBGE.[35] I use population-by-age data to compute school enrollment *rates*. IBGE provided 2000 Census data (an 11.7% sample covering 20.3 million people). I have data on individual income, demographics, and school attendance (including level and administrative dependence).

The National Treasury (Tesouro Nacional) provided data on revenue and expenditure by type. A valid concern is that a nominal amount of currency may have more purchasing power in some areas—possibly in poorer or more rural parts of Brazil—than in others. To address this concern, I convert all measures of revenue, expenditure, and income to constant, 2005 São Paulo currency using a set of spatial income deflators for Brazil computed by Ferreira *et al.* (2003).

The Superior Electoral Court (Tribunal Superior Eleitoral) provided data on the results of municipal elections during 1996-2008. From these, I computed the three time-varying political variables described earlier, and coded a dummy for whether the mayor represented a socialist party. Brian Wampler, Leonardo Avritzer, and Yves Zamboni provided data on which municipalities with populations over 50,000 had participatory budgeting (PB) during 1992-2008. I used these to construct a dummy for a municipality having PB sometime during the sample period.

Finally, the Institute of Applied Economic Research (IPEA)[36] provided data on hectares of coffee, cocoa, and bananas in each municipality in 1994. Annual price data for these commodities are available from the International Monetary Fund's International Financial Statistics.

6 Results

6.1 First stage results

Table 6 presents estimates of the first-stage regressions. Actual municipal revenue is robustly positively correlated with simulated revenue. Column (1) indicates that a 1 Reais increase in simulated revenue is associated with 0.42 Reais more revenue.[37] The F-statistic on the excluded

[35] I have population by age data for 1991, 1996, 2000, 2007. I compute annual estimates by linear interpolation.

[36] In Portuguese, Instituto de Pesquisa Econômica Aplicada.

[37] Several factors can explain why this coefficient is not equal to 1.0. First, municipalities can reduce collections of tax revenue in response to an influx of money from FUNDEF/B. Second, the panel is rather long; changes in the political and economic landscape of a municipality over time may drive the coefficient up or down.

instrument is 347. I next interact simulated revenue with income and inequality, to explicitly allow municipalities to convert revenue shocks from the law into revenue differently, according to their levels of income and inequality. An increase in simulated revenue increases revenue more in higher-income municipalities (significant at the 0.01 level), and may increase it less in more unequal municipalities (significant at the 0.10 level in some specifications). The F-statistic on the joint significance of the excluded instruments is over 150 in every first stage specification but one, where it is 93. There do not appear to be weak instrument problems. In these and all specifications, I cluster standard errors at the municipality level since revenue varies at this level.

6.2 Effects of FUNDEF/B on public pre-primary investment

Table 7 presents OLS and IV estimates of the effects of revenue on investment in public pre-primary education, with and without population and income controls. The IV estimates, which account for the endogeneity of revenue, support the predictions. A reform-induced revenue increase leads to higher enrollment in pre-primary education, higher education expenditure per capita (i.e. per population), and a larger share of revenue being spent on education. Whether measured by the teacher quality index or the infrastructure quality index, the quality of public pre-primary education decreases with a revenue increase, which is of special interest given that theory could not sign this coefficient.

In all IV specifications, revenue is significant at the 0.01 level, and the income and population controls have little effect on its point estimate. Column (2) shows that a standard deviation increase in per capita revenue (about 530 R$, or 210 USD, in 2005 currency) is associated with a 4.3 percentage point increase in public pre-primary enrollment (a variable whose mean is 0.23). This is an 18% increase over mean enrollment. The negative effects on quality are also large; columns (4) and (6) indicate that a standard deviation revenue increase is associated with a 1.9 standard deviation decrease in the teacher quality index, and a 0.36 standard deviation decrease in the infrastructure quality index. Additional revenue leads to an influx of new students, but municipalities accommodate higher enrollment by hiring less-educated teachers or increasing class sizes, and by using lower-quality infrastructure. Column (8) shows that an extra 1 R$ of

revenue per capita results in 0.37 R$ more per capita education spending—close to education spending's average 30% share of total expenditure. Column (10) shows that education spending as a fraction of revenue is increasing in revenue; a standard deviation revenue increase leads to 2.7 percentage points more revenue going to education.

OLS estimates are sufficiently different from IV estimates to suggest bias. Both suggest that higher revenue is associated with higher pre-primary enrollment and higher education spending, but the OLS estimates are smaller in magnitude than the IV estimates. This is consistent with the previously-described channels of downward bias. If revenue is higher precisely where there are fewer child care needs or a mayor with a high discount rate, then OLS would mute the effects of revenue on pre-primary enrollment and education spending due to its correlation with these unobservables. Under OLS, revenue has a near-zero effect on both teacher and infrastructure quality (columns 4 and 6), which is statistically insignificant in the case of infrastructure quality.

6.3 The roles of income and inequality

According to the predictions, median income and inequality moderate the effects of a reform-induced revenue increase. One expects higher median income and higher inequality to result in: (i) a smaller increase in public pre-primary enrollment, (ii) a smaller decrease in public pre-primary quality, (iii) a smaller increase in public education expenditure, and (iv) a larger increase in public expenditure on goods without private sector substitutes, like infrastructure. In this section, I test these predictions and find empirical support for each.

Table 8 shows the results for public pre-primary enrollment. Per capita revenue has a positive effect on enrollment, but this effect is statistically significantly smaller (at the 0.01 level) in richer and more unequal municipalities. By column (5), if two otherwise identical municipalities have Gini coefficients at the 25th and the 75th percentiles (0.37 and 0.41), a revenue increase that would lead a median inequality municipality to enroll 100 new pre-primary students would lead the more unequal municipality to enroll only 87, and the more equal municipality to enroll 113. Also by column (5), if two otherwise identical municipalities have median per capita incomes at the 25th and 75th percentiles (1150 and 3020 in constant 2005 R$/year), a

revenue increase that would lead a median income municipality to enroll 100 new pre-primary students would lead the richer municipality to enroll only 28, and the poorer municipality to enroll 163. Figure 4 illustrates how this varies across municipalities at each decile of income and of inequality. The income gradient is steeper than the inequality gradient, but both profoundly affect a municipality's propensity to expand public pre-primary enrollment following a revenue shock. The results are similar in column (4), where I use mean instead of median income.

Table 9 presents results for four measures of public pre-primary quality: pre-primary students per teacher, the fraction of pre-primary teachers with post-secondary education, the teacher quality index, and the infrastructure quality index. In keeping with predictions, I find that both richer and more unequal municipalities are more likely to use an exogenous revenue increase to improve public pre-primary quality ($\theta_2, \delta_2 > 0$). This finding is statistically significant at the 0.01 level in most specifications, although the inequality interaction term is insignificant in the students per teacher and teacher quality index regressions. Again comparing otherwise identical municipalities with Gini coefficients at the 25th and 75th percentiles, a standard deviation revenue increase leads the more unequal municipality to have 1.3 - 1.5 percentage points more teachers with post-secondary education (6 - 7% of the mean rate) and 0.02 - 0.03 standard deviations higher infrastructure quality. Comparing otherwise identical municipalities at the 25th and 75th percentiles of per capita income, a standard deviation revenue increase leads the richer municipality to have 6.6 - 6.7 fewer students per teacher (35% of mean class size), 8 percentage points more post-secondary-educated teachers (35% of the mean rate), a teacher quality index that is 1.1 standard deviations higher, and an infrastructure quality index that is 0.14 - 0.16 standard deviations higher.

Table 10 examines expenditure by sector. I consider education and infrastructure spending, both in per capita terms and as a share of total revenue. Inequality interacted with revenue has the expected negative effect on education spending as a share of revenue, but is insignificant in all other specifications. Revenue interacted with income is always significant at the 0.01 level, and has the predicted sign; negative for education spending ($\theta_3 < 0$), and positive for infrastructure spending ($\theta_4 > 0$). By columns (4) and (8), if two otherwise identical municipalities have median

per capita incomes at the 25th and the 75th percentiles, a revenue increase that would lead a median income municipality to spend 1 R$ of it on education would lead the richer municipality to spend only 0.67 R$, and the poorer municipality to spend 1.29 R$. On the other hand, a revenue increase that would lead a median income municipality to spend 1 R$ of it on infrastructure would lead the richer municipality to spend 1.10 R$, and the poorer municipality to spend only 0.91 R$. Figure 5 illustrates how this varies across municipalities at each decile of income. Once again, the income gradient is steeper than the inequality gradient, but both strongly influence a municipality's public spending patterns. The results are similar in columns (3) and (7), where I use mean instead of median income.[38]

As a partial test of the exogeneity of the instruments, I estimate overidentified models with four excluded instruments: simulated revenue, and its interactions with median income, average income, and the Gini. The estimates of θ and δ are almost identical. The Hansen J test statistics of each model, distributed χ^2_1, indicate that the instruments are appropriately uncorrelated with the disturbance process. I consistently fail to reject the null hypothesis that the instruments affect investment only through their effect on revenue and its interactions with income and inequality.[39]

6.4 Contrasting the collective choice and political power channels

These results can be explained by either of two existing theories, or channels: a collective choice channel, and a political power channel. If both matter, then the estimates reflect their combined impact. In this section, I attempt to apportion the effects between the two channels by focusing on municipalities where the political power channel is suppressed. In these municipalities, the effects are likely due to the collective choice channel.

Ideally, I would randomly assign some municipalities to determine public investment without preferring any citizen over another. This would effectively turn off the political power channel. If the effects of income and inequality were the same in treated and untreated municipalities,

[38]Results shown in Appendix Table A.4 indicate that the findings are substantially similar when I use logged values of revenue and the outcome variables. Also, the addition of political and agricultural controls has virtually no effect on the coefficients interpreted in this analysis, or their standard errors.

[39]A table of these results is available upon request.

this would suggest that the collective choice channel accounts for the results. If income and inequality mattered in untreated but not in treated municipalities, this would suggest that the political power channel accounts for the results. If they had significant but distinct effects in treated versus untreated municipalities, this would suggest a role for each channel.

Such a policy experiment is not feasible. However, following Brazil's return to democracy in 1985, many municipalities put in place an institution that did something similar: Participatory Budgeting (PB). Under PB, citizens vote on how to use a share of municipal revenue designated for their neighborhood, and elect neighborhood representatives to make municipality-wide spending decisions. Citizens deliberate and negotiate over the distribution of public resources. Policymakers are required to publicize budgets and expenditures to promote transparency (Boulding and Wampler 2010). Case studies from Brazil suggest that PB increases participation of marginalized groups, leads to more pro-poor expenditures, and increases government accountability (Souza 2001). By dividing the budget into shares, PB mechanically ensures a quite equal distribution of power (unless the rich somehow live in all neighbors, and dominate policymaking).

According to Melo (2009), "One of the most salient aspects of PB is that most experiences originated in municipalities where an elected mayor lacked the support of the local legislative chamber (municipal council)." The legislature can veto any budget, but finds it politically difficult to do so when the budget comes from the people, through PB. When divided government paralyzes policymaking, mayors implement PB to get the policy process moving again. More often then not, PB has remained in place following its implementation.

I use data on which municipalities had PB at some point during the sample period. The data are available for all municipalities with a population over 50,000—about 14% of the sample. I estimate the baseline model for three sets of municipalities: large municipalities (population over 50,000), large municipalities with PB, and large municipalities without PB.

Table 11 shows how the effects of income and inequality on spending vary by the presence of PB. I use three dependent variables: the public pre-primary enrollment rate, education spending per capita, and the teacher quality index. I measure income with the per capita median. Inequality does not seem to moderate the effect of revenue on public pre-primary quantity or

quality in larger municipalities. A quick correlation of the Gini coefficient and median income reveals that while it is 0.01 in the full sample, it is 0.22 among these larger municipalities. This may be driven by higher variance in employment opportunities in cities (which are themselves generally richer), while rural areas are more uniformly poor. This high correlation and the small sample size may complicate estimation of the partial effects of income and inequality. Of course, in more urban areas, inequality may just have little impact on public investment.

Per capita median income is a robustly significant factor (at the 1% level) explaining the use of an exogenous revenue increase in larger municipalities. Whether or not PB is in place, I find that richer municipalities are less likely to use an exogenous revenue increase to boost education spending or pre-primary enrollment, and more likely to improve public pre-primary quality. However, the estimates are significantly smaller in magnitude (closer to 0) for the sub-sample of PB municipalities (for which the political channel is suppressed). This has two major implications. First, the collective choice channel matters, and its independent effect supports the predictions of the formal model. That is, even when PB is in place and the political power channel is suppressed, the distribution of income still moderates how revenue is spent, in accordance with the collective choice model presented in Section 4. Second, the political power channel also matters. Specifically, turning on the political power channel (going from PB to no PB) intensifies the negative effect of higher median income on public pre-primary enrollment and education investment, and intensives its positive effect on public pre-primary quality. Higher median income seems to be associated with lower political power among those consuming public pre-primary (disproportionately, the poor). Moving to PB and thus eliminating the connection between income and policy influence is associated with a smaller negative effect of income on pre-primary enrollment, and a smaller positive effect of income on public pre-primary quality.

Comparing the results for the full sample vs. PB sub-sample offers insight into the effects of each channel. For pre-primary enrollment, moving from full sample to PB sub-sample leads the negative coefficient on revenue interacted with income to drop in magnitude by about 30% (though it is still negative). The difference is statistically significant at the 0.16 level if I cluster standard errors (at the municipality level) and at the 0.02 level if I do not cluster. For the teacher

quality index, moving from full sample to PB sub-sample leads this positive coefficient to drop by about 17%. However, the difference is statistically insignificant at conventional levels. For public education spending, moving from full sample to PB sub-sample leads the negative coefficient on revenue interacted with median income to drop in magnitude by about 58% (though it is still negative), and the negative coefficient on revenue interacted with inequality (significant only for this dependent variable) to drop in magnitude by about 45% (though it is still negative). The difference is statistically significant at the 0.01 level, whether or not I cluster.

Given an exogenous revenue increase, this suggests that richer municipalities are less likely to expand public pre-primary enrollment for two reasons: because they have a collective choice of less public pre-primary (about 70% of the effect) and because citizens with the highest demand for public pre-primary (disproportionately, the poor) have less political power in such settings (about 30% of the effect). In other words, both the collective choice and political power channels are operative. In the case of education spending, the collective choice channels accounts for about 42% of the effect of income and 55% of the effect of inequality (with 62% and 45%, respectively, due to the political power channel). Finally, in the case of pre-primary quality, the collective choice channel seems to account for most of the effect. The point estimates suggest that it accounts for 83%, and it may account for more as the coefficients, θ_2, are not statistically significantly different in the PB and non-PB sub-samples.

The PB estimates should be interpreted with care because PB is not randomly imposed on municipalities. While municipalities with similar income distributions differ in whether they use PB, those that use it are presumably enthusiastic about transparency and ensuring the poor a political voice. It is not obvious that PB would have equally large effects in municipalities that do not want it. Overall, I take these estimates as suggestive evidence that both channels matter.

7 Robustness

7.1 An alternate measure of equal access to political power

It is of course possible that participatory budgeting does not fully suppress the political power channel. Within neighborhoods, for example, elites might exert disproportionate power over

the use of the assigned share of revenue. Additionally, PB may mean slightly different things in different municipalities. Finally, the large municipalities for which I have PB data could be unique, casting doubt on the validity of the results in less-urban contexts. I address these concerns in this section by considering a second measure of equal access to political power for which I have data for all municipalities.

If the poor still have less political power than the rich under PB, my analysis would underestimate the importance of the political power channel. Ideally, I want to examine the effects of income and inequality on revenue use in political spheres where the poor have as much influence as the rich. As a robustness check, I divide the sample into municipality-years with socialist party mayors and those without, and estimate the same model. On average, about 17% of municipalities have a socialist party mayor, defined as an elected mayor whose party affiliation is one of the following five: PDT, PT, PSB, PPS, or PCdoB.[40] These are left-wing, grass-roots parties. There is not a significant relationship between per capita expenditure and having a socialist party mayor, after controlling for municipality fixed effects, median income, and population. However, these parties have historically pursued policies aligned with what blue-collar workers indicate they want in opinion polls. Socialist party mayors are likely to be elected precisely because the poor are equally- or relatively more-politically involved compared to the rich. An advantage of this analysis is that I have accurate, time-varying data for the full sample. I leverage off of within-municipality changes in the party in power over time.

Appendix Table A.2 presents these regression results. I examine the same three dependent variables as in the PB analysis, and the findings are nearly identical. Whether or not there is a socialist party mayor, richer municipalities are less likely to use an exogenous revenue increase to boost education spending or pre-primary enrollment, and more likely to improve pre-primary quality. These results are always significant at the 0.01 level. Again, the estimates on income interacted with revenue are significantly smaller in magnitude (closer to 0) for the sub-sample of municipalities with socialist party mayors (for which the political channel is suppressed) than

[40]In order of frequency, the Democratic Labor Party (Partido Democrático Trabalhista, PDT), Workers' Party (Partido dos Trabalhadores, PT), Brazilian Socialist Party (Partido Socialista Brasileiro, PSB), Socialist Popular Party (Partido Popular Socialista, PPS), and Communist Party of Brazil (Partido Comunista do Brasil, PCdoB).

for the non-socialist party municipalities. The difference is statistically significant at the 0.15 level for public pre-primary enrollment, and at the 0.02 level for public pre-primary quality and education spending. Thus, both channels appear to be operative, and their relative importance is remarkably similar to the PB analysis despite the fact that this is a much larger and more varied set of municipalities. Given an exogenous revenue increase, richer municipalities are less likely to expand pre-primary enrollment for two reasons: because they have a collective choice of less public pre-primary education (about 65% of the effect), and because the poor have relatively less political power in such settings (about 35% of the effect). In the case of public education spending, the collective choice channel explains about 60% of the effect of median income on how revenue is spent, and the political power channel explains about 40%. In the case of public pre-primary teacher quality, the collective choice channel explains about 84% of the effect, and the political power channel explains about 16%. Once again, both channels matter.

7.2 Addressing the issue of heterogenous expenditure constraints

While not an issue of identification, one may be concerned that the results are driven in part by how constrained municipalities are to spend FUNDEF/B receipts on education (as opposed to another good, or a tax rate reduction). If median income or inequality is correlated with this constrainedness, the results may be partly mechanical. In this section, I explore this possibility using two different methods, and conclude that the estimated effects are robust.

Recall that a municipality must spend at least 25% of revenue on education, and must spend all net FUNDEF/B receipts on education. This implies that FUNDEF/B receipts are more fungible for municipalities spending above-minimally on education before the reform; they can reduce *voluntary* education spending in response to a windfall. Doing so effectively allows them to use some of the windfall on *any* spending priority (including tax rebates). But this means that the same education investment is effectively more expensive for a less-constrained municipality, as there are more potential uses of the money. That is, there is a price effect. While highly-constrained municipalities include high and low income, equal and unequal municipalities, a concern is that the intensity of the price effect is correlated with median income or inequality.

There are a few ways to address this concern. First, I segment the sample by the constrainedness of municipalities to spend revenue in the education sector. I then examine whether the effects of median income and inequality depend on the level of constrainedness. Second, I show results where education spending per capita takes the place of revenue per capita in the baseline econometric specification. The first stage equations then explicitly allow richer or more unequal municipalities to convert exogenous revenue into education spending differently. In the second stage, I then observe how the distribution of income affects the use of education funds to invest in pre-primary quantity and quality. Both approaches have advantages and drawbacks, discussed in a moment. Importantly, they both support the baseline analysis.

I divide municipalities into categories of constrainedness as follows. A municipality must be a net beneficiary ('winner') of FUNDEF/B to be constrained. Among winners, completely unconstrained municipalities (17% of winners) are those that received a windfall in 1998 that was smaller than their above-minimal education spending in 1997, making the windfall completely fungible. These municipalities could repeat their 1997 education spending level in 1998, and did not need to spend past that. Completely constrained municipalities (29%) spent the minimum on education in 1997, so the entire 1998 windfall had to go to education. Between these two extremes are municipalities with some above-minimal education spending in 1997, but which received a 1998 windfall that was larger than this voluntary spending, making the windfall only partially fungible. These municipalities could reduce above-minimal education spending to zero in 1998, but were still forced to spend more on education than they did in 1997. I divide these municipalities into two similarly-sized groups: those constrained to keep their own[41] spending on education at 85-99.9% of its 1997 level (28%), and those constrained to keep their own education spending 85% of its 1997 level or even less constrained (27%).[42]

Appendix Table A.1 presents the first and second stage results for the four subsamples, for all losers, and for all winners. For parsimony, I show the results with pre-primary enrollment as the dependent variable, and use median income. The other results are similar. In the first

[41]Own means not coming from FUNDEF/B (i.e. total education spending minus net gain from FUNDEF/B).

[42]Note that this category is distinct from completely unconstrained municipalities, which received less from FUNDEF than they had in voluntary education spending.

stage, simulated revenue is again associated with higher observed revenue. In the second stage, the interactions of median income and inequality with revenue are significant at the 0.05 level or higher for winners as a whole, and for all four sub-samples. The coefficients θ_1 and δ_1 have the expected negative sign for all of the sub-samples, and their magnitudes are remarkably similar to the baseline results. θ_1 is always between -0.05 and -0.11, which is similar to the -0.064 in the full sample. δ_1 is always between -0.04 and -0.08, which is similar to the -0.061 in the full sample. Within each of these sub-samples, municipalities face approximately the same price effects from FUNDEF/B, and yet inequality and income have similarly-sized effects. It does not appear to be the case that these coefficients are simply picking up the effects of constrainedness.

For the sub-sample of losers from the 1998 reform, revenue interacted with the Gini coefficient remains negative and significant at the 0.05 level (although it is almost 40% smaller in magnitude than for the full sample). However, revenue interacted with median income is now insignificant. There are a few possible reasons that these results differ from those for the full sample—chief among them that it is easier for a winner than a loser to re-optimize. Municipalities may vary in their ability to issue new local taxes to fill a hole in the budget; doing so requires local tax collection infrastructure (which may be scant in the case of a historic reliance on transfer revenue). While both rich and poor municipalities may wish to raise revenue following a FUNDEF/B loss, rich municipalities may raise more—not because of a greater desire to raise revenue, but simply because of a greater ability to do so. This may explain the fact that θ_1 is insignificant for the sub-set of losers. However, winners probably offer more insight into the effects of income and inequality on the use of revenue; for winners, their effects will not pick up the ability to adjust local tax policy quickly. It is thus meaningful that the results for all winners are very similar to the results for the full sample, and equally significant.

There are some drawbacks to this analysis, including weaker first stage specifications. This motivates a second check that the interactions of revenue with income and inequality are not simply capturing their correlation with constrainedness to spend revenue on education.

I next study the role of constrainedness by replacing per capita revenue, r_{it} with per capita education spending in equation (11). Now, the first stage explicitly allows municipalities to differ

on how much of an exogenous revenue shock they convert into education spending. Appendix Table A.3 presents first and second stage IV results, which use the same excluded instruments. I compare this table with the baseline results. Once again, θ_1 and δ_1 are robustly negative. Comparing the coefficients θ_1 and δ_1 to the mean of education spending, and doing the same for the baseline results, one sees that the magnitude of the effects changes very little.[43] This supports the findings of the constrainedness sub-sample analysis.

This analysis also has limitations. Simulated revenue may affect public pre-primary investment through channels other than education spending, violating the exclusion restriction.[44] However, it is meaningful that both of these constrainedness analyses confirm the main results.

7.3 Correlates of inequality and income

I treat inequality and median income as broad concepts that summarize important dimensions of society. However, my findings may be less interesting if income and inequality are simply picking up the effect of some variable correlated with them that also conditions how revenue is spent. For example, they may be correlated with higher initial enrollment in public pre-primary ('saturation' from the start, and less room for growth), or with urbanization (creating more economies of scale in provision, and thus more room for enrollment growth).

To ensure that this is not the case, I individually enter four new interactions with revenue into the model: the 1997 enrollment rate in public pre-primary education, and the year 2000 fraction of the municipality that was urban, labor force participation rate, and index of racial fractionalization.[45] Due to problems of weak instruments, I cannot enter all of these in the same specification. However, as Appendix Table A.4 shows, their individual inclusion has negligible effects on the main point estimates and their statistical significance. My findings seem to come from what income and inequality imply for the number of people wanting public pre-primary education, and from their political influence, rather than one of these more mechanical channels.

[43] The same analysis, applied to pre-primary quality, also reveals almost no change in the size of the effects.

[44] E.g., investment in roads and public transit might boost enrollment by reducing the cost of getting to school.

[45] Urbanization is as classified by IBGE (2000). Labor force participation is the fraction of the adult population that is economically active. Racial fractionalization is an ethnolinguistic fractionalization (ELF) index (an HHI), computed using data on the population in each of four categories: black or brown, white, asian, and indigenous.

8 Conclusions

This paper makes two key contributions to our understanding of factors affecting the public provision of goods for which private substitutes are available (like education and health care). Its main contribution is an analysis of how an area's income distribution affects how its government allocates revenue between goods with and without private substitutes. I carry out an empirical analysis of public investment in Brazil's over 5,000 municipalities during 1995-2008. I focus on pre-primary education, for which private substitutes are readily available. My study circumvents two problems which have impacted related empirical studies: the tendency for the provision and quality of such goods to be highly-regulated by the national government (masking local policy preferences), and the endogeneity of public sector revenue (which is required to fund them). Pre-primary education in Brazil is a unique good over which municipalities have true investment discretion. To address endogeneity issues, I exploit a 1998 change in Brazil's education finance law that generates exogenous variation in municipalities' revenue. Specifically, I form a simulated instrumental variable that encapsulates the credibly exogenous variation in revenue generated by the law, but *excludes* variation due to the municipalities' own actions. I instrument for actual (endogenous) revenue with the simulated instrument, thereby testing how different municipalities differentially spend an exogenous shock to revenue. I find that an exogenous revenue increase attributable to the law change causes municipalities to spend more on education and to increase public pre-primary enrollment. However, richer and more unequal municipalities are significantly less likely to expand education spending and public pre-primary enrollment. The funds they do not spend on education are significantly more likely to end up in public infrastructure like parks and roads, which do not have private sector substitutes.

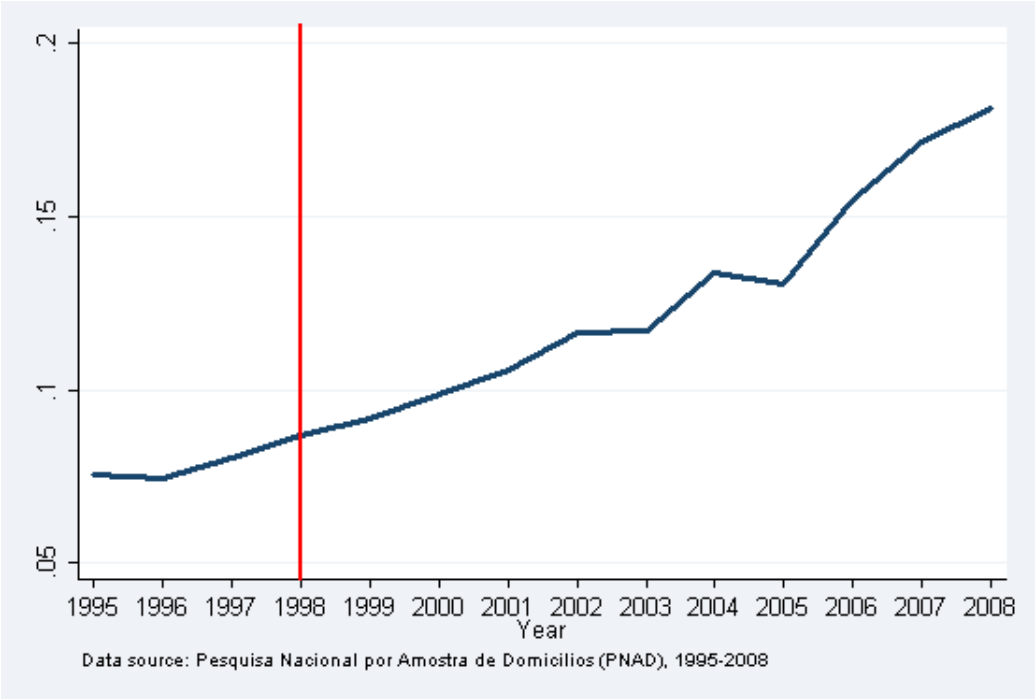
The paper's secondary contribution is an attempt to apportion the estimated effects of the distribution of income between two channels described in existing literatures: a collective choice channel and a political power channel. The collective choice channel hypothesizes that societies with higher income and more unequal income simply have more people who consume a private sector version of publicly-provided goods. Because they are consuming private versions, they vote for low spending on the public sector counterparts, leading to less of them under majority

voting. The political power channel hypothesizes that people have control over public policy that is roughly proportionate to their share of income, as opposed to their share of votes. Thus, the poor may have little ability to make government publicly supply the goods they most demand (including public education), especially as others grow richer relative to them. The existing literature says little about the relative importance of each channel. This is problematic because they do not necessarily imply the same socially-optimal policy interventions to address low equilibrium provision. To shed light on the role of each channel, I make use of the fact that some municipalities use Participatory Budgeting (PB), allowing citizens to vote over expenditures. To the extent that PB reduces the ability of the rich to buy disproportionate political influence, its presence suppresses the political power channel. Thus, the remaining effects are likely due to the collective choice channel. My estimates suggest that the political power channel accounts for about 30% of the effects, and the collective choice channel for about 70%. Both channels play an important role in determining how the distribution of income affects public investment.

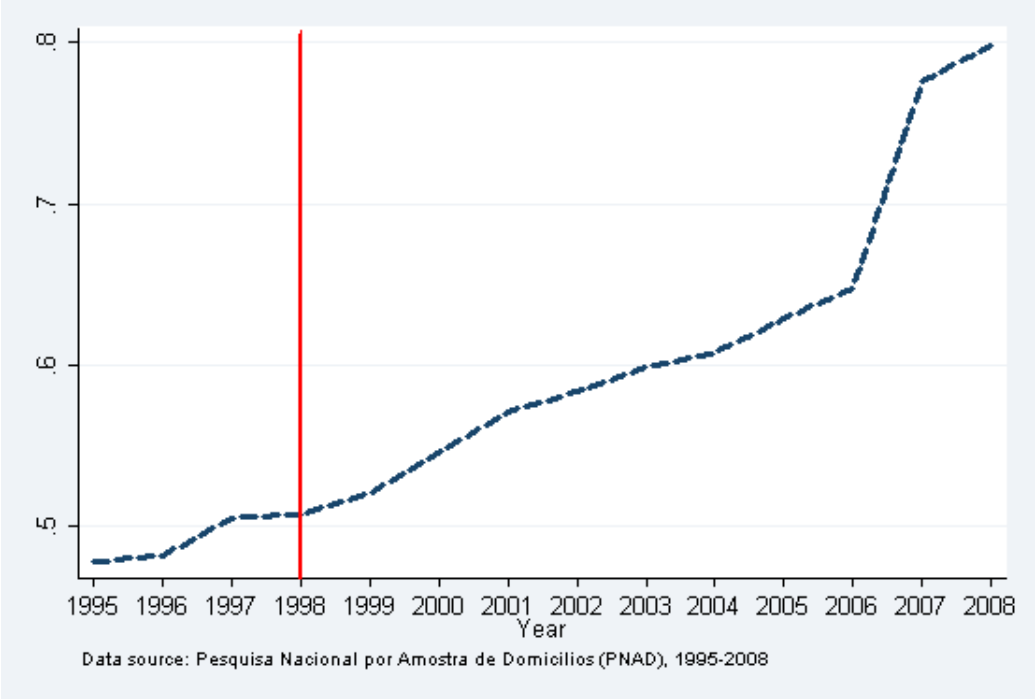
These findings have at least two important policy implications. First, revenue transfers that target the poorest local governments and those with the lowest income inequality are likely to be most effective in expanding public education investment and pre-primary enrollment. Policymakers in those municipalities already have a relatively strong desire to spend their next R$ on these uses. Any education finance equalization program should take this into account. In the Brazilian case, it would seem that a nation-wide education finance equalization reform would target the poorest municipalities better than a within-state distribution like FUNDEF/B. Second, governance reforms that ensure everyone an equal voice in policymaking do matter and can affect policy outcomes. In particular, they seem to empower those who use publicly-provided goods with private substitutes, like education or health care.

Figure 1: Fraction of Brazilian Children in Formal Pre-Primary Education Institutions, 1995-2008

(a) Ages 0-3, Crèche Education

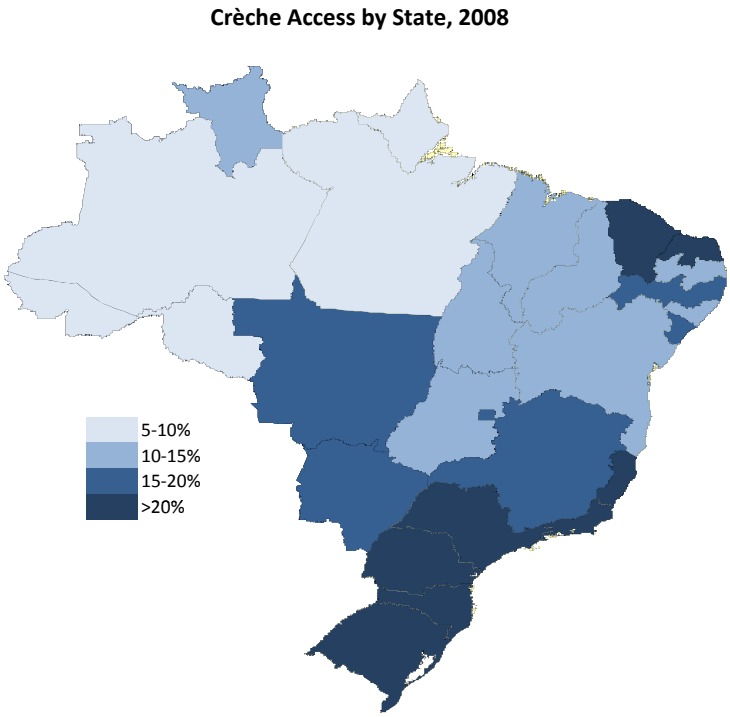


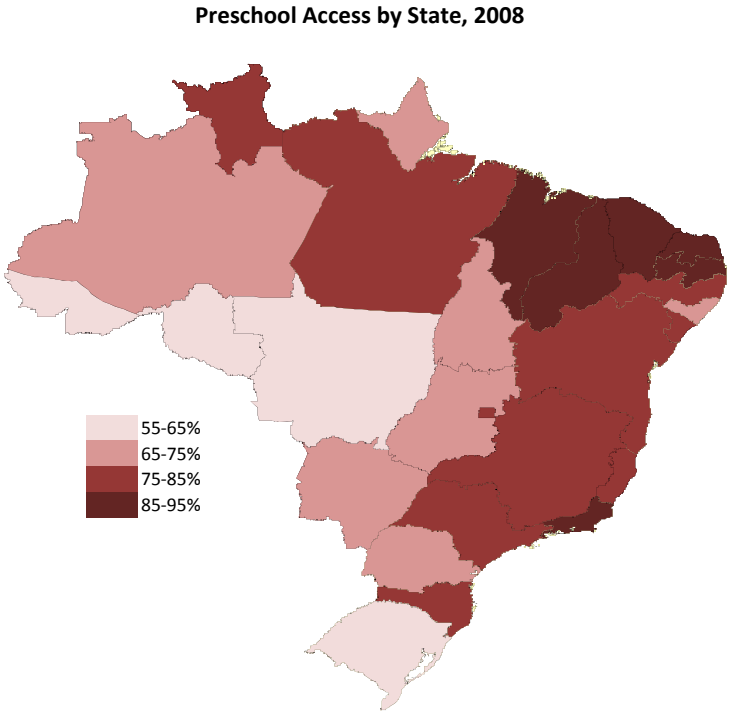
(b) Ages 4-6, Preschool Education



Notes: Enrollment is in any type of pre-primary school (public or private), and based on parental self-reports. The vertical line indicates the implementation of the FUNDEF school reform in 1998.
Sources: Pesquisa Nacional por Amostra de Domicilios (PNAD) (1995-2008), with calculations performed by author.

Figure 2: Pre-Primary Enrollment Rate by State in Brazil, 2008

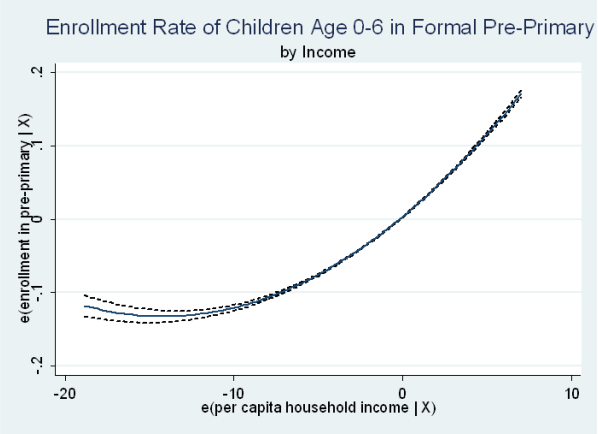




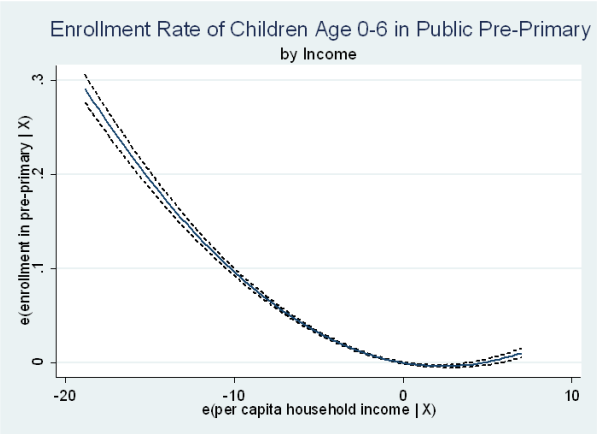
Notes: Crèche (Preschool) access is the rate of enrollment in school (public or private) for children aged 0-3 (aged 4-6), based on parental self-reports.
Sources: Pesquisa Nacional por Amostra de Domicilios (PNAD) (2008), with calculations performed and maps drawn by author.

Figure 3: Partial Regression Plots with Quadratic Fit, Showing How Enrollment in Formal Pre-Primary Education Varies with Household Income, 2000

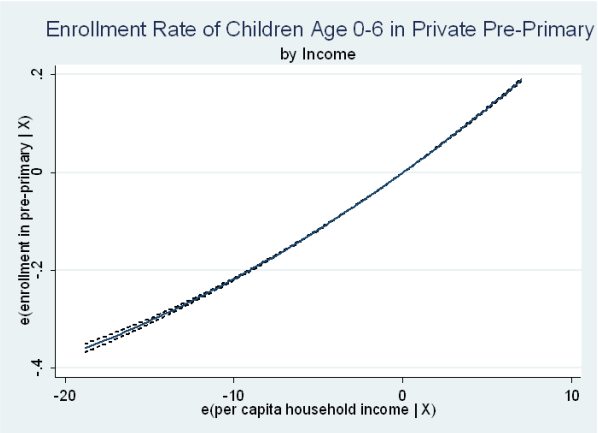
(a) Pre-Primary



(b) Public Pre-Primary

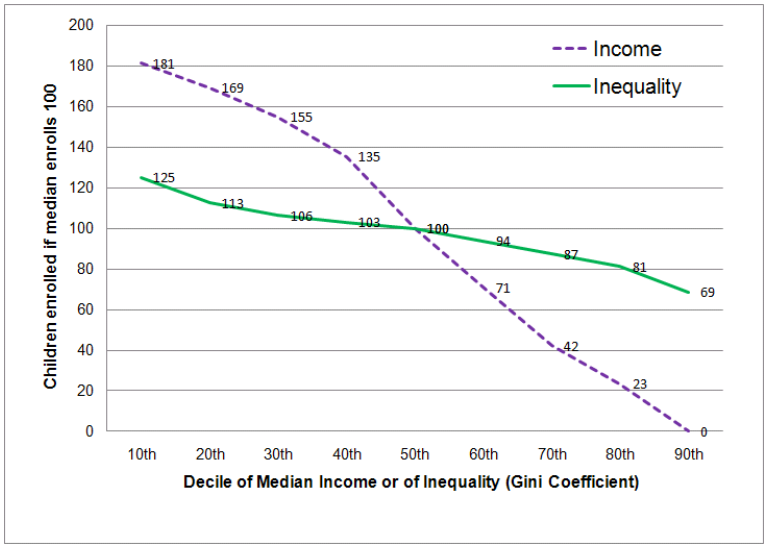


(c) Private Pre-Primary



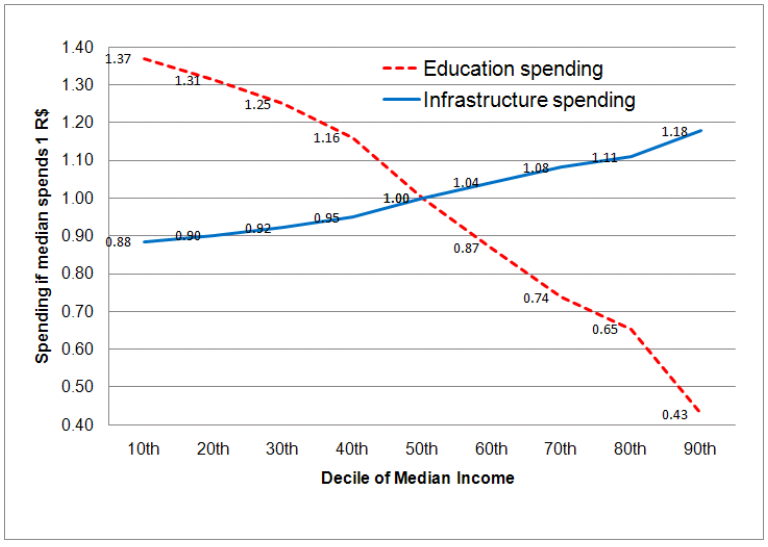
Notes: X is a vector of controls including child age and gender, household size, municipality fixed effects, and household head gender, migration status, years of education dummies, race dummies, and age dummies. Units of income (x-axis) are 100s of 2000 Reais. 95% confidence intervals appear as dashed lines.
Sources: 2000 Brazilian Census, 11.7% sample (IBGE).

Figure 4: Number of New Public Pre-Primary Students that Municipalities At Different Levels of Income and Inequality Would Enroll if the Median Municipality Enrolled 100 New Students



Notes: This figure presents two line graphs, both created using three coefficients (Revenue, Revenue × median income, and Revenue × gini) from column (5) of Table 8. For each graph, I assume that municipalities at each decile receive the same influx of revenue, and that this influx is large enough to compel the median municipality (50th percentile) to enroll 100 new public pre-primary students. This amount of revenue is not necessarily the same in the two graphs. For the median income graph, I assume that inequality takes the sample median value. For the inequality graph, I assume that median income takes the sample median value.
Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Figure 5: Expenditure on Education and on Infrastructure in Municipalities At Different Levels of Income and Inequality if the Median Income Municipality Spends 1 R$



Notes: This figure presents two line graphs, both created using three coefficients (Revenue, Revenue × median income, and Revenue × gini) from Table 10. The education spending graph comes from column (4) and the infrastructure spending graph comes from column (8). For each graph, I assume that municipalities at each decile receive the same influx of revenue, and that this influx compels the median income municipality (50th percentile) to spend 1 R$ on the relevant spending category. This amount of revenue is not necessarily the same in the two different line graphs. I assume that inequality takes the sample median value.
Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Table 1: Means of Quality Variables, Which Suggest that Private Pre-Primary Education is of Higher Quality than Public

Measure of Quality	Private (1)	Public (2)	Difference (3)
Pre-primary students per pre-primary teacher	15.3	18.3	3.1
	(0.062)	(0.045)	(0.083)**
Fraction of pre-primary teachers with post-secondary education	0.231	0.197	-0.035
	(0.002)	(0.001)	(0.002)**
Fraction of pre-primary institutions with own school building	0.979	0.949	-0.030
	(0.001)	(0.002)	(0.002)**
Fraction of pre-primary institutions with electricity	0.997	0.903	-0.095
	(0.001)	(0.001)	(0.002)**
Fraction of pre-primary institutions with indoor bathroom	0.960	0.799	-0.161
	(0.001)	(0.001)	(0.003)**
Fraction of pre-primary institutions with library	0.623	0.197	-0.427
	(0.003)	(0.001)	(0.003)**
Fraction of pre-primary institutions with computer	0.849	0.370	-0.479
	(0.002)	(0.002)	(0.003)**

Notes: Standard errors are in parentheses. ** indicates p<.01.
Sources: Author's calculations based on school- and teacher-level data from the 2008 Census of Schools (Censo Escolar).

Table 2: Number of Municipalities, by Tercile of Income Per Capita and Tercile of Net Per-Child Receipts (Net Per-Child Benefits) from FUNDEF Education Finance Reform, 1998

	Lowest Receipts	Middle Receipts	Highest Receipts
Poorest	51	372	710
Middle	664	695	369
Richest	638	286	273
Total	1353	1353	1352

Notes: The total number of municipalities in the table is smaller than the national total, due to missing data on per capita municipal income or per-capita FUNDEF receipts data.
Sources: Author's calculations based on data from Tesouro Nacional and IBGE (1998).

Table 3: Number of Municipalities, by 1997 Education Spending as % of Revenue and 1997 Transfers as % of Revenue, Showing How Crowd-Out of Local Revenue with FUNDEF Revenue Was Limited

		Transfers as % of Revenue					
		<75 %	(75-85] %	(85-90] %	(90-95] %	(95-100] %	Total
Panel A: All Municipalities							
	>32.5%	53	86	87	168	270	664
	(30, 32.5]%	58	106	90	123	182	559
Education Spending	(27.5, 30]%	122	186	140	180	235	863
as % of Revenue	(25, 27.5]%	172	245	175	229	269	1,090
	25%	597	544	263	248	214	1,866
	Total	1,002	1,167	755	948	1,170	5,042
Panel B: Predicted Net Beneficiaries of FUNDEF							
	>32.5%	42	56	65	125	245	533
	(30, 32.5]%	30	63	54	89	153	389
Education Spending	(27.5, 30]%	70	101	65	87	162	485
as % of Revenue	(25, 27.5]%	75	112	77	106	165	535
	25%	303	214	95	99	130	841
	Total	520	546	356	506	855	2,783

Notes: 25% of revenue is the imposed minimum expenditure on education, and thus the lowest expenditure category. Predicted net beneficiaries are municipalities that, as of 1997, would receive more from FUNDEF than they were required to pay in if the rules of FUNDEF were applied to 1997 enrollment and revenue levels.
Sources: Author's calculations based on data from Tesouro Nacional (1997).

Table 4: Correlation Matrix, Measures of Income and Inequality

	(1)	(2)	(3)
(1) Average income per capita, 10,000s of 2005 Reais	1.0		
(2) Median income per capita in 2000, 10,000s of 2005 Reais	0.72	1.0	
(3) Gini coefficient in 2000	-0.04	0.01	1.0

Source: IBGE (1995-2008).

Table 5: Summary Statistics

Variable	**Mean**	**Std. Dev.**
Fraction of 0-6 population enrolled in a municipal pre-primary school	0.23	0.15
Municipal pre-primary students per pre-primary teacher	19.26	7.49
Fraction of municipal pre-primary teachers with post-secondary education	0.22	0.27
Pre-primary teacher quality index, first PC from 2-factor PCA	0	1.02
Fraction of municipal pre-primary institutions with own school building	0.82	0.34
Fraction of municipal pre-primary institutions with electricity	0.82	0.34
Fraction of municipal pre-primary institutions with an indoor bathroom	0.76	0.36
Fraction of municipal pre-primary institutions with a library	0.17	0.28
Fraction of municipal pre-primary institutions with a computer	0.22	0.35
Pre-primary school infrastructure quality index, first PC from 5-factor PCA	0	1.74
Education spending as fraction of revenue	0.3	0.06
Education spending per capita, 100s 2005 Reais	2.62	1.32
Infrastructure and urban development spending as fraction of revenue	0.09	0.06
Infrastructure and urban development spending per capita, 100s 2005 Reais	0.83	0.68
Revenue per capita, 100s 2005 Reais	9.61	5.32
Simulated revenue per capita, 100s, 2005 Reais	6.45	3.03
Average income per capita, 10,000s of 2005 Reais	0.64	0.48
Median income per capita in 2000, 10,000s of 2005 Reais	0.22	0.12
Gini coefficient in 2000	0.39	0.03
Population, 100,000s	0.32	1.92
Population aged 0-6, 100,000s	0.04	0.21
Population aged 7-15, 100,000s	0.06	0.3
Municipality had participatory budgeting at some point during 1995-2008	0.06	0.24
Municipality has a socialist party mayor	0.17	0.38
Fraction of population that lived in urban areas in 2000	0.59	0.23
Labor force participtaion rate (share of population economically active)	0.55	0.09
Racial fractionalization index in 2000	0.38	0.12

Notes: Data are summarized over 1995-2008 and over all municipalities for which data are available (N=59,424). One exception is the dummy for participatory budgeting during 1995-2008, which is summarized only for municipalities with populations of 50,000 or greater (N=5,704).

Sources: Author's calculations based on data from IBGE, INEP, Tesouro Nacional, IPEA, and TSE.

Table 6: IV First Stage Results, Showing the Effect of Simulated Revenue from the Law Change on Actual Revenue

Dependent Variable:	Municipal per capita revenue (mean = 9.61)						Revenue x avg inc	Revenue x med inc	Revenue x Gini coefficient	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Simulated revenue	0.423	0.155	0.029	0.791	0.462	0.260	-0.832	-0.349	-0.503	-0.565
	(0.023)**	(0.031)**	(0.036)	(0.193)**	(0.185)*	(0.190)	(0.199)**	(0.053)**	(0.071)**	(0.073)**
Simulated revenue x avg income		0.529			0.526		1.288		0.187	
		(0.047)**			(0.048)**		(0.103)**		(0.018)**	
Simulated revenue x med income			2.070			2.053		1.561		0.691
			(0.146)**			(0.147)**		(0.072)**		(0.052)**
Simulated revenue x gini				-0.938	-0.779	-0.582	0.203	0.032	1.503	1.566
				(0.498)+	(0.470)+	(0.476)	(0.516)	(0.139)	(0.183)**	(0.184)**
Per capita income	1.537	1.507	1.490	1.536	1.506	1.489	12.261	0.448	0.533	0.528
	(0.093)**	(0.090)**	(0.091)**	(0.093)**	(0.090)**	(0.091)**	(0.179)**	(0.027)**	(0.033)**	(0.033)**
Population	-1.051	-1.096	-1.052	-1.034	-1.081	-1.041	0.465	-0.088	-0.302	-0.288
	(0.340)**	(0.360)**	(0.357)**	(0.336)**	(0.356)**	(0.354)**	(0.278)+	(0.048)+	(0.105)**	(0.104)**
0-6 population	-3.450	-3.234	-3.162	-3.440	-3.227	-3.157	1.166	-0.501	-1.020	-1.000
	(0.944)**	(0.900)**	(0.888)**	(0.947)**	(0.901)**	(0.889)**	(1.236)	(0.318)	(0.345)**	(0.343)**
7-15 population	4.759	4.680	4.602	4.701	4.629	4.563	-1.391	0.487	1.425	1.404
	(1.467)**	(1.428)**	(1.424)**	(1.456)**	(1.419)**	(1.418)**	(1.173)	(0.208)*	(0.456)**	(0.458)**
Observations	59388	59388	59388	59388	59388	59388	59388	59388	59388	59388
Municipalities	4843	4843	4843	4840	4840	4840	4840	4840	4840	4840
F Stat, Excluded Instruments	346.57	235.77	290.94	183.24	157.22	199.82	92.60	235.26	198.23	231.69

Notes: An observation is a municipality - year. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of simulated revenue per capita is 6.45, the mean of 1997 average per capita income is 0.49, the mean of 2000 median per capita income is 0.22, and the mean Gini coefficient is 0.39. Population is measured in 100,000s.

Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Table 7: OLS and IV Results, Showing the Effects of Revenue on Several Measures of Pre-Primary Investment

Dependent Variable:	Pre-primary enrollment (mean=0.23)		Teacher quality index (mean=0)		Infrastructure quality index (mean=0)		Education spending per capita (mean=2.62)		Education spending (% of revenue) (mean=0.30)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: OLS Results										
Revenue	0.002	0.002	0.014	0.010	0.005	0.002	0.169	0.167	-0.004	-0.003
	(0.000)**	(0.000)**	(0.003)**	(0.003)**	(0.002)**	(0.002)	(0.003)**	(0.003)**	(0.000)**	(0.000)**
Average income		0.008		0.194		0.183		0.027		-0.004
		(0.003)*		(0.027)**		(0.019)**		(0.021)		(0.001)**
Population		-0.032		-0.087		0.103		-0.247		-0.012
		(0.010)**		(0.049)+		(0.055)+		(0.122)*		(0.003)**
0-6 population		-0.089		-0.202		0.446		-1.212		-0.088
		(0.023)**		(0.310)		(0.175)*		(0.311)**		(0.021)**
7-15 population		0.031		0.581		-0.411		1.487		0.092
		(0.036)		(0.377)		(0.226)+		(0.564)**		(0.026)**
Observations	59248	59248	51841	51841	56900	56900	58749	58749	58827	58827
Municipalities	4842	4842	4797	4797	4818	4818	4837	4837	4837	4837
Panel B: IV Results										
Revenue	0.009	0.008	-0.379	-0.363	-0.134	-0.121	0.380	0.372	0.005	0.005
	(0.002)**	(0.002)**	(0.039)**	(0.036)**	(0.019)**	(0.017)**	(0.019)**	(0.018)**	(0.001)**	(0.001)**
Average income		-0.002		0.755		0.367		-0.274		-0.016
		(0.005)		(0.071)**		(0.034)**		(0.039)**		(0.002)**
Population		-0.024		-0.533		-0.040		0.004		-0.002
		(0.009)**		(0.141)**		(0.037)		(0.060)		(0.002)
0-6 population		-0.067		-1.307		0.075		-0.532		-0.061
		(0.023)**		(0.594)*		(0.213)		(0.319)+		(0.020)**
7-15 population		-0.001		2.182		0.156		0.498		0.052
		(0.037)		(0.743)**		(0.236)		(0.354)		(0.018)**
Observations	59154	59154	51732	51732	56798	56798	58648	58648	58726	58726
Municipalities	4748	4748	4688	4688	4716	4716	4736	4736	4736	4736

Notes: An observation is a municipality - year. I instrument for revenue using simulated revenue. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of per capita revenue is 9.61 and the mean of average per capita income is 0.64. Population is measured in 100,000s.
Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Table 8: IV Results, Showing How Income and Inequality Moderate the Effect of Revenue on Public Pre-Primary Enrollment

Dependent Variable: Fraction of 0-6 population enrolled in municipal pre-primary school (mean = 0.23)					
	(1)	(2)	(3)	(4)	(5)
Revenue	0.004	0.003	0.030	0.027	0.028
	(0.002)+	(0.002)	(0.005)**	(0.006)**	(0.005)**
Revenue x average income	-0.017			-0.018	
	(0.002)**			(0.002)**	
Revenue x median income		-0.057			-0.064
		(0.005)**			(0.005)**
Revenue x gini			-0.051	-0.054	-0.061
			(0.011)**	(0.012)**	(0.012)**
Average income	0.213	0.033	-0.007	0.226	0.032
	(0.022)**	(0.004)**	(0.005)	(0.022)**	(0.004)**
Population	-0.018	-0.034	-0.015	-0.008	-0.025
	(0.007)**	(0.009)**	(0.007)*	(0.006)	(0.006)**
0-6 population	-0.070	-0.126	-0.048	-0.050	-0.111
	(0.029)*	(0.030)**	(0.023)*	(0.030)+	(0.030)**
7-15 population	-0.003	0.057	-0.033	-0.038	0.026
	(0.031)	(0.032)+	(0.036)	(0.034)	(0.029)
Observations	59154	59154	59118	59118	59118
Municipalities	4748	4748	4745	4745	4745

Notes: An observation is a municipality - year. I instrument for revenue and its interaction with these covariates using simulated revenue and its interaction with the same covariates. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, the fraction of public primary school students in state or federal (non-municipal) schools, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of per capita revenue is 9.61, the mean of average per capita income is 0.64, the mean of 2000 median per capita income is 0.22, and the mean Gini coefficient is 0.39. Population is measured in 100,000s.

Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Table 9: IV Results, Showing How Income and Inequality Moderate the Effect of Revenue on Public Pre-Primary Quality

Dependent Variable:	Pre-primary students per PP teacher (mean = 19.2)		Fraction PP teachers with post-secondary educ. (mean = 0.22)		Teacher quality index (mean = 0)		Infrastructure quality index (mean = 0)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Revenue	1.498	1.693	-0.034	-0.036	-0.209	-0.240	-0.176	-0.178
	(0.394)**	(0.368)**	(0.011)**	(0.011)**	(0.058)**	(0.052)**	(0.032)**	(0.031)**
Revenue x average income	-2.051		0.024		0.329		0.077	
	(0.125)**		(0.004)**		(0.019)**		(0.010)**	
Revenue x median income		-6.672		0.079		1.074		0.276
		(0.367)**		(0.010)**		(0.051)**		(0.029)**
Revenue x gini	0.422	-0.441	0.059	0.068	-0.152	-0.002	0.186	0.218
	(0.890)	(0.803)	(0.023)*	(0.023)**	(0.131)	(0.114)	(0.067)**	(0.066)**
Average income	22.295	0.158	-0.245	0.007	-3.453	0.062	-0.602	0.203
	(1.498)**	(0.281)	(0.043)**	(0.009)	(0.231)**	(0.041)	(0.111)**	(0.025)**
Population	3.993	2.158	-0.043	-0.021	-0.578	-0.277	-0.089	-0.015
	(1.383)**	(0.993)*	(0.016)**	(0.013)+	(0.173)**	(0.109)*	(0.040)*	(0.031)
0-6 population	15.532	9.042	0.088	0.164	-1.173	-0.131	0.040	0.306
	(4.055)**	(3.133)**	(0.078)	(0.082)*	(0.403)**	(0.278)	(0.196)	(0.171)+
7-15 population	-16.360	-9.671	0.149	0.070	2.146	1.057	0.247	-0.042
	(6.554)*	(4.924)*	(0.092)	(0.090)	(0.734)**	(0.484)*	(0.241)	(0.200)
Observations	51942	51942	52546	52546	51701	51701	56765	56765
Municipalities	4691	4691	4708	4708	4685	4685	4713	4713

Notes: An observation is a municipality - year. I instrument for revenue and its interaction with these covariates using simulated revenue and its interaction with the same covariates. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, the fraction of public primary school students in state or federal (non-municipal) schools, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of per capita revenue is 9.61, the mean of average per capita income is 0.64, the mean of 2000 median per capita income is 0.22, and the mean Gini coefficient is 0.39. Population is measured in 100,000s.
Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Table 10: IV Results, Showing How Income and Inequality Moderate the Effect of Revenue on Education and Infrastructure Spending

Dependent Variable:	Education spending (% of revenue) (mean = 0.30)		Education spending per capita (mean = 2.62)		Infrastructure spending (% of revenue) (mean = 0.09)		Infrastructure spending per capita (mean = 0.83)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Revenue	0.008	0.009	0.287	0.295	-0.002	-0.001	0.082	0.105
	(0.002)**	(0.002)**	(0.036)**	(0.035)**	(0.003)	(0.003)	(0.035)*	(0.034)**
Revenue x avg income	-0.007		-0.133		0.004		0.039	
	(0.001)**		(0.011)**		(0.001)**		(0.010)**	
Revenue x med income		-0.028		-0.606		0.013		0.136
		(0.002)**		(0.036)**		(0.003)**		(0.028)**
Revenue x gini	-0.013	-0.017	0.120	0.034	-0.009	-0.006	-0.031	0.002
	(0.005)*	(0.005)**	(0.079)	(0.075)	(0.006)	(0.006)	(0.059)	(0.062)
Average income	0.069	0.001	1.422	0.119	-0.042	0.003	-0.478	-0.104
	(0.009)**	(0.002)	(0.142)**	(0.037)**	(0.010)**	(0.003)	(0.114)**	(0.042)*
Population	0.002	-0.005	0.016	-0.130	-0.002	0.004	0.060	0.130
	(0.003)	(0.002)*	(0.043)	(0.062)*	(0.005)	(0.005)	(0.061)	(0.074)+
0-6 population	-0.060	-0.089	-0.657	-1.264	0.011	0.032	0.238	0.467
	(0.021)**	(0.026)**	(0.306)*	(0.409)**	(0.028)	(0.028)	(0.229)	(0.240)+
7-15 population	0.045	0.074	0.599	1.214	0.011	-0.014	-0.268	-0.542
	(0.018)*	(0.022)**	(0.329)+	(0.448)**	(0.034)	(0.035)	(0.300)	(0.346)
Observations	58690	58690	58612	58612	52480	52480	54532	54532
Municipalities	4733	4733	4733	4733	4609	4609	4612	4612

Notes: An observation is a municipality - year. I instrument for revenue and its interaction with these covariates using simulated revenue and its interaction with the same covariates. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, the fraction of public primary school students in state or federal (non-municipal) schools, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of per capita revenue is 9.61, the mean of average per capita income is 0.64, the mean of 2000 median per capita income is 0.22, and the mean Gini coefficient is 0.39. Population is measured in 100,000s.
Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Table 11: IV Results, Showing Heterogenous Effects of Income and Inequality Depending on the Presence of Participatory Budgeting

Dependent Variable:	Fraction of 0-6 population enrolled (mean = 0.22)			Education spending per capita (mean = 1.99)			Teacher quality index (mean = 0.06)		
	All	PB	No PB	All	PB	No PB	All	PB	No PB
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Revenue	0.028	0.016	0.041	0.700	0.475	0.730	-0.096	0.050	-0.061
	(0.013)*	(0.015)	(0.020)*	(0.105)**	(0.101)**	(0.152)**	(0.142)	(0.168)	(0.221)
Revenue x median income	-0.055	-0.038	-0.067	-0.565	-0.240	-0.669	0.642	0.532	0.625
	(0.011)**	(0.012)**	(0.017)**	(0.082)**	(0.083)**	(0.111)**	(0.111)**	(0.143)**	(0.166)**
Revenue x gini	-0.019	-0.012	-0.035	-0.711	-0.389	-0.814	-0.191	-0.551	-0.144
	(0.024)	(0.036)	(0.034)	(0.180)**	(0.210)+	(0.249)**	(0.275)	(0.373)	(0.396)
Average income	0.004	0.020	-0.014	-0.074	0.135	-0.126	0.154	-0.006	0.177
	(0.008)	(0.009)*	(0.013)	(0.085)	(0.090)	(0.132)	(0.077)*	(0.083)	(0.132)
Population	-0.012	-0.007	-0.017	-0.029	0.051	-0.198	0.040	0.023	0.064
	(0.005)*	(0.005)	(0.018)	(0.053)	(0.049)	(0.135)	(0.057)	(0.074)	(0.224)
0-6 population	-0.053	-0.062	-0.007	-0.327	-0.170	-0.043	0.481	0.386	0.166
	(0.018)**	(0.022)**	(0.041)	(0.199)	(0.255)	(0.311)	(0.215)*	(0.282)	(0.480)
7-15 population	0.011	0.004	0.010	0.349	0.027	0.749	-0.219	0.092	-0.442
	(0.019)	(0.019)	(0.068)	(0.219)	(0.241)	(0.506)	(0.302)	(0.354)	(0.676)
Observations	6225	2102	4123	6163	2076	4087	5713	1931	3782
Municipalities	539	172	367	539	172	367	538	172	366
F Stat, Excluded Instruments:									
Dep. Var. is revenue	23.52	20.12	14.33	20.08	16.29	12.78	21.44	20.50	12.17
Dep. Var. is revenue x med inc	48.02	20.76	26.49	45.22	20.44	26.16	44.03	19.55	26.47
Dep. Var. is revenue x gini	18.73	9.51	16.38	15.84	6.96	14.60	16.35	10.12	13.78
Kleibergen-Papp rk LM Stat (underidentification)	30.80	16.59	14.43	31.43	14.07	17.81	27.74	15.03	13.63

Notes: An observation is a municipality - year. Large municipalities are those with population exceeding 50,000 in year *t*. PB is the existence of participatory budgeting institutions at some point during 1995-2008. I instrument for revenue and its interaction with these covariates using simulated revenue and its interaction with the same covariates. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, the fraction of public primary school students in state or federal (non-municipal) schools, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of per capita revenue is 7.82, the mean of average per capita income is 0.52, the mean of 2000 median per capita income is 0.22, and the mean Gini coefficient is 0.39. Population is measured in 100,000s.

Sources: Author's calculations based on data from IBGE, INEP, Tesouro Nacional, and the Avrtizer-Wampler participatory budgeting database.

Appendices

A Appendix Tables

Table A.1: Results by Sub-sample of Constrainedness, Showing How Income and Inequality Moderate the Effect of Revenue on Public Pre-Primary Enrollment

	All losers	All winners	Completely unconstrained winners	< 85% constrained winners	85-99.9% constrained winners	Completely constrained winners
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: First Stage Results						
Dependent Variable: Municipal per capita revenue (mean = 9.61)						
Simulated revenue	0.401	0.515	-0.405	-0.157	0.913	0.878
	(0.347)	(0.224)*	(0.874)	(0.318)	(0.371)*	(0.438)*
Simulated revenue x med income	1.135	2.334	3.031	1.942	2.550	2.111
	(0.263)**	(0.226)**	(0.585)**	(0.814)*	(0.391)**	(0.341)**
Simulated revenue x gini	-0.201	-1.126	0.930	0.759	-2.285	-1.841
	(0.843)	(0.561)*	(2.146)	(0.787)	(0.910)*	(1.098)+
Observations	28870	29655	4923	7856	8200	8676
Municipalities	2225	2357	390	637	651	679
F-Statistic, Excluded Instruments	144.16	109.60	29.07	13.79	13.64	57.32
Panel B: Second Stage Results						
Dependent Variable: Fraction of 0-6 population enrolled in a municipal pre-primary school (mean = 0.23)						
Revenue	0.006	0.047	0.024	0.066	0.049	0.032
	(0.008)	(0.007)**	(0.014)+	(0.019)**	(0.013)**	(0.012)**
Revenue x median income	0.012	-0.080	-0.061	-0.065	-0.113	-0.049
	(0.008)	(0.007)**	(0.015)**	(0.031)*	(0.031)**	(0.011)**
Revenue x gini	-0.037	-0.076	-0.036	-0.076	-0.079	-0.063
	(0.019)*	(0.014)**	(0.027)	(0.021)**	(0.014)**	(0.028)*
Observations	28754	30122	4909	7844	8176	8665
Municipalities	2222	2402	390	637	651	679

Notes: An observation is a municipality - year. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, the fraction of public primary school students in state or federal (non-municipal) schools, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of simulated revenue per capita is 6.45, the mean of 1997 average per capita income is 0.49, the mean of 2000 median per capita income is 0.22, and the mean Gini coefficient is 0.39.
Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Table A.2: IV Results, Showing Heterogenous Effects of Income and Inequality Depending on Whether Mayor is a Socialist Party Member

Dependent Variable:	Fraction of 0-6 population enrolled (mean = 0.23)			Education spending per capita (mean = 2.62)			Teacher quality index (mean = 0)		
	All	Socialist	Non	All	Socialist	Non	All	Socialist	Non
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Revenue	0.029	0.010	0.032	0.206	0.116	0.229	-0.296	-0.265	-0.285
	(0.007)**	(0.013)	(0.007)**	(0.047)**	(0.095)	(0.050)**	(0.059)**	(0.151)+	(0.063)**
Revenue x median income	-0.065	-0.042	-0.066	-0.569	-0.342	-0.580	1.139	0.960	1.159
	(0.006)**	(0.013)**	(0.007)**	(0.035)**	(0.076)**	(0.042)**	(0.053)**	(0.130)**	(0.058)**
Revenue x gini	-0.074	-0.003	-0.082	0.025	0.249	-0.015	0.130	-0.159	0.142
	(0.013)**	(0.022)	(0.015)**	(0.075)	(0.161)	(0.087)	(0.118)	(0.284)	(0.134)
Average income	0.035	0.017	0.033	0.268	0.172	0.269	0.061	0.133	0.038
	(0.007)**	(0.011)	(0.007)**	(0.064)**	(0.090)+	(0.064)**	(0.057)	(0.134)	(0.055)
Population	-0.025	-0.034	-0.019	-0.208	-0.341	-0.173	-0.285	-0.385	-0.255
	(0.008)**	(0.014)*	(0.008)*	(0.092)*	(0.103)**	(0.093)+	(0.110)**	(0.214)+	(0.105)*
0-6 population	-0.092	-0.121	-0.074	-1.361	-1.623	-1.349	-0.085	0.454	-0.331
	(0.035)**	(0.049)*	(0.048)	(0.430)**	(0.312)**	(0.664)*	(0.291)	(0.888)	(0.329)
7-15 population	0.013	0.055	-0.005	1.426	1.678	1.427	1.034	0.693	1.184
	(0.034)	(0.054)	(0.040)	(0.512)**	(0.408)**	(0.603)*	(0.435)*	(0.939)	(0.593)*
Observations	54693	9181	45073	54301	9117	44743	48571	8269	39817
Municipalities	4613	1681	4505	4613	1681	4502	4589	1618	4449
F Stat, Excluded Instruments:									
Dep. Var. is revenue	71.22	15.72	84.27	65.79	14.94	74.82	81.32	11.01	90.38
Dep. Var. is revenue x med inc	310.92	90.59	240.60	313.85	88.75	243.37	422.43	90.82	357.36
Dep. Var. is revenue x gini	100.00	19.54	107.94	99.61	20.35	102.21	80.40	11.87	81.18
Kleibergen-Papp rk LM Stat (underidentification)	129.33	18.53	139.08	118.42	17.88	124.33	112.00	11.75	116.53

Notes: An observation is a municipality - year. I instrument for revenue and its interaction with these covariates using simulated revenue and its interaction with the same covariates. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, the fraction of public primary school students in state or federal (non-municipal) schools, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of per capita revenue is 9.61, the mean of average per capita income is 0.64, the mean of 2000 median per capita income is 0.22, and the mean Gini coefficient is 0.39. Population is measured in 100,000s.
Sources: Author's calculations based on data from IBGE, INEP, Tesouro Nacional, and TSE.

Table A.3: IV Results with Education Spending in Place of Revenue, Showing How Income and Inequality Moderate the Effect of Revenue on Public Pre-Primary Enrollment

Panel A: IV First Stage

Dependent Variable:	Education spending per capita (mean = 2.62)			Revenue x avg inc	Revenue x med inc	Revenue x gini	Revenue x gini
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Simulated revenue	0.156	0.188	0.273	-0.297	-0.081	-0.093	-0.058
	(0.007)**	(0.059)**	(0.060)**	(0.056)**	(0.016)**	(0.022)**	(0.022)**
Simulated revenue x avg income		0.001		0.219		-0.002	
		(0.016)		(0.021)**		(0.006)	
Simulated revenue x med income			-0.318		0.217		-0.138
			(0.054)**		(0.024)**		(0.020)**
Simulated revenue x gini		-0.083	-0.147	0.491	0.095	0.405	0.378
		(0.149)	(0.148)	(0.138)**	(0.041)*	(0.056)**	(0.056)**
Observations	58749	58713	58713	58802	58802	58802	58802
Municipalities	4837	4834	4834	4834	4834	4834	4834
F Stat, Excluded Instruments	511.43	175.72	193.60	44.63	47.68	203.14	217.60

Panel B: IV Second Stage

Dependent Variable: Fraction of 0-6 population enrolled in a municipal pre-primary school (mean = 0.23)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Education spending	0.026	0.024	0.028	0.018	0.116	0.087	0.093
	(0.006)**	(0.006)**	(0.007)**	(0.008)*	(0.022)**	(0.024)**	(0.025)**
Education spending x avg income			-0.088			-0.091	
			(0.012)**			(0.012)**	
Education spending x med income				-0.361			-0.372
				(0.049)**			(0.047)**
Education spending x gini					-0.225	-0.146	-0.186
					(0.048)**	(0.054)**	(0.057)**
Observations	58481	58481	58481	58481	58445	58445	58445
Municipalities	4736	4736	4736	4736	4733	4733	4733
Includes population and income controls?	No	Yes	Yes	Yes	Yes	Yes	Yes

Notes: An observation is a municipality - year. I instrument for per capita education spending using simulated per capita revenue. Robust standard errors are in parentheses, and clustered at the municipality level. Except where indicated otherwise, all specifications include controls for population, age 0-6 population, age 7-15 population, and average per capita income. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10.
Sources: Author's calculations based on data from IBGE, INEP, and Tesouro Nacional.

Table A.4: Table of Specification Checks

Additional controls:	1997 enrollment in PP x revenue (1)	2000 % urban x revenue (2)	2000 LFP rate x revenue (3)	2000 racial frac x revenue (4)	political controls (5)	agriculture controls (6)	log-log spec. (7)	log-level spec. (8)
Panel A:	Fraction of 0-6 population enrolled in a municipal pre-primary school (mean = 0.23)						Log 0-6 enrollment	
Revenue	0.029	0.028	0.026	0.029	0.028	0.029	-0.114	0.110
	(0.008)**	(0.005)**	(0.006)**	(0.005)**	(0.005)**	(0.005)**	(0.203)	(0.028)**
Revenue x median income	-0.064	-0.060	-0.067	-0.054	-0.064	-0.063	-0.325	-0.267
	(0.006)**	(0.007)**	(0.006)**	(0.013)**	(0.005)**	(0.005)**	(0.035)**	(0.027)**
Revenue x gini	-0.061	-0.058	-0.060	-0.066	-0.061	-0.063	-0.849	-0.133
	(0.012)**	(0.013)**	(0.012)**	(0.006)**	(0.012)**	(0.012)**	(0.428)*	(0.063)*
Observations	59118	58841	59118	59118	58845	59118	48556	48744
Panel B:	Education spending per capita (mean = 2.62)						Log education spending	
Revenue	0.206	0.283	0.305	0.300	0.292	0.304	0.768	0.165
	(0.073)**	(0.035)**	(0.040)**	(0.036)**	(0.035)**	(0.035)**	(0.079)**	(0.016)**
Revenue x median income	-0.645	-0.537	-0.596	0.068	-0.602	-0.606	-0.186	-0.287
	(0.051)**	(0.047)**	(0.042)**	(0.075)	(0.036)**	(0.036)**	(0.014)**	(0.017)**
Revenue x gini	0.035	0.114	0.030	-0.614	0.041	0.014	-0.548	0.059
	(0.083)	(0.078)	(0.075)	(0.036)**	(0.075)	(0.075)	(0.168)**	(0.036)
Observations	58612	58337	58612	58612	58346	58612	48953	49157
Panel C:	Teacher quality index (mean = 0)						Log teacher quality index	
Revenue	-0.204	-0.240	-0.340	-0.236	-0.242	-0.242	1.051	-0.312
	(0.061)**	(0.053)**	(0.059)**	(0.052)**	(0.052)**	(0.052)**	(0.399)**	(0.058)**
Revenue x median income	1.087	1.074	0.966	0.044	1.079	1.065	1.355	1.068
	(0.054)**	(0.062)**	(0.063)**	(0.121)	(0.052)**	(0.051)**	(0.065)**	(0.056)**
Revenue x gini	0.006	-0.014	0.040	1.064	0.001	0.009	1.921	0.187
	(0.115)	(0.122)	(0.114)	(0.052)**	(0.115)	(0.115)	(0.839)*	(0.125)
Observations	51701	51452	51701	51701	51499	51701	43878	44024

Notes: An observation is a municipality - year. I instrument for revenue and its interaction with these covariates using simulated revenue and its interaction with the same covariates. Robust standard errors are in parentheses, and clustered at the municipality level. All specifications include municipality and year fixed effects, as well as a linear time trend interacted with the pre-reform, 1997 levels of per capita revenue, per capita transfer revenue, the fraction of public primary school students in state or federal (non-municipal) schools, pre-primary enrollment, and pre-primary enrollment squared. ** indicates p<.01; * indicates p<.05; + indicates p<.10. The mean of per capita revenue is 9.61, the mean of 2000 median per capita income is 0.22, and the mean Gini coefficient is 0.39. 1997 is the 1997 enrollment rate in public pre-primary education. % urban is the fraction of the population that lives in urban areas. LFP is the fraction of the adult population that is economically active. Racial frac is an index of racial fractionalization (HHI) constructed from population by race data.
Sources: Author's calculations based on data from IBGE, INEP, Tesouro Nacional, and TSE.

B Institutional Detail: Pre-Primary Education in Brazil, FUNDEF, and FUNDEB

In 1985, Brazil began a process of re-democratization following military dictatorship. The government put forth a new constitution in 1988, and decentralized substantial power to state and municipal governments. As of 2000, there were 5,507 municipalities. Municipal governments are led by an elected mayor and an elected city council comprised of a minimum of nine and a maximum of 55 councilmen, according to population size. Local elections are competitive and held every four years, and voting is compulsory for those over 17. Everyone 16 and older can vote. The mayoral candidate with the largest vote share is elected (with runoff elections in municipalities with populations over 200,000 if no candidate wins at least 50% of the vote). City council seats are filled by a system of open-list proportional representation. Legislative, budgetary, and administrative authority are concentrated in the mayor's office, and the city council is largely responsible for approving mayoral directives (Couto and Abrucio 1995; Wampler 2007).

The federal government has placed a lot of emphasis on pre-primary education over the last two decades. The 1988 Brazilian constitution formally recognized age 0-6 education as the right of every child and the responsibility of municipal governments. The 1996 National Education Guidelines and Frameworks Law emphasized the educational value of pre-primary education by formally integrating crèches (age 0-3) and preschools (age 0-6, and 0-5 starting in 2007) under the Ministry of Education. National enthusiasm for pre-primary education has been spurred on by an alarming rate of failure out of first grade: 29.3 percent as of 2001 (UNESCO 2006). This compares unfavorably even with most Sub-Saharan African countries, which have the world's highest regional average failure rate. Additionally, Brazil performs far below peers with similar per capita GDP on Program for International Student Assessment (PISA) tests. With a lot of studies emerging saying that early childhood education can equip children with the cognitive and non-cognitive skills required for success in primary school and beyond, the government has been keen to capitalize on this. Souza (2005), Minister of Education during 1995-2002, describes the federal government's motivations for greater education investment and monitoring of performance indicators.

Despite this rhetoric, however, the federal government has largely recused itself from pre-primary education policy. Part of this is an artefact of the 1988 Constitution, which gave considerable policy autonomy to municipal governments. As Plank (1996) notes: "The Constitution' concession of independence to municipalities significantly reduces the power both of the Ministry of Education and state governments, while greatly expanding opportunity for administrative and policy innovation." Political pressure for municipal autonomy had been building during the 20 years of military rule preceding the 1988 Constitution. About 54% of the congressmen drafting the 1988 Constitution had been previously involved in local politics as mayors or city councilmen, and they wanted to financially weaken the federal government. Souza (2002) notes, "The 1988 Constitution incorporated municipalities as part of the federation together with the states, reflecting a tradition of municipal autonomy and little state control in municipal matters."

The federal government has interfered in municipal education policy by imposing an education spending floor: at least 25% of municipal revenue from any source—local or transfer revenue. The federal government has also passed several education finance reform laws. In 1998, the government implemented the "Fund for the Development of Elementary Education and Teachers" (Fundo de Manutenção e Desenvolvimento do Ensino Fundamental e de Valorização do Magistério), or FUNDEF. This policy was expanded in the 2007 "Fund for the Development

and Maintenance of Basic Education" (Fundo de Manutenção e Desenvolvimento da Educação Básica), or FUNDEB.

FUNDEF obligated each of Brazil's state and municipal governments to pay 15% of each of four intergovernmental transfers into a state-level education fund. These four transfer receipts were typically the largest four sources of transfer revenue for municipal governments, and included: transfers from the municipal participation fund (FPM), the tax on goods and services (ICMS), the tax on industrialized products (IPI), and transfers under the complementary law. In Portuguese, these are the Fundo de Compensacao dos Estados Exportadores (IPI), the Imposto Sobre Circulacao de Mercadorias e Servicos (ICMS), the Parte do Fundo de Participacao dos Municipios (FPM), and the Lei Complementar (LC 87/96) transfer. The federal government sets IPI tax rates and the state government sets ICMS tax rates subject to federal minima and maxima. FPM is known as the "Revenue Sharing Fund of the Municipalities." Of the federal government's proceeds from the collection of taxes on income and earnings and on industrialized products, 22.5% is given to Brazil's municipalities as an FPM transfer. In most municipalities, these four transfers form the majority of the municipal revenue base. In some sense, these are local taxes; the state and federal governments set the rates and bases, and actually collect the taxes, but they then transfer the revenue to municipalities on the basis of its municipality of origin. These payments into the school fund *did* count toward the 25% of revenue that must be spent on education, but municipalities also had to spend 25% of all other revenue (from sources other than these four transfers), and an additional 10% of these four transfers, on education. For more details, see Gordon and Vegas (2005), Estevan (2007), and UNESCO (2007).

FUNDEF generated 27 education funds: one for each state, and one for the Federal District. Fund receipts were redistributed back to municipalities within each state so that each governments's share of the pie was equal to its share of the state's total enrolled primary school children. The state government itself also paid into the fund by the same set of rules, and also claimed a share of the pie equal to its share of students (although state governments are generally less involved in primary education). All fund receipts had to be spent on education. Additionally, 60% of fund receipts had to be spent exclusively on teacher compensation. Each municipality was also required to establish a council that would oversee expenditures (Sands 2008). If gross fund receipts alone were not enough to achieve a federal minimum investment level per primary school child (set annually), the federal government would 'top off' the fund to ensure minimal primary school expenditure per child. Importantly, this federal 'top-off' ensured that primary education was already universal and of minimal required quality before the municipality spent the 10% or more of additional revenue mandated by the 1988 Constitution's 25% spending floor on education. As UNESCO (2007) notes, the intention was that states would spend this additional (non-school fund) money on secondary education, and municipalities would spend it on pre-primary education and other education-related expenditures.

On December 23, 1997, President Fernando Henrique Cardoso and Minister of Education Paulo Renato Souza issued a decree announced the amount of the federal top-off policy that would be put into effect for 1998 (and would be revised periodically). FUNDEF was implemented at the start of the new school year in 1998, with municipal receipts from the fund based on the 1997 Census of Schools (Censo Escolar) enrollments data.

In 2007, FUNDEB increased the fraction of transfer revenue to be contributed to the state education fund: from 15% in 2006 to 16.67% in 2007, 18.33% in 2008, and 20% in 2009 onward. Also, while FUNDEF only considered primary school students in assigning capitation grants, FUNDEB expanded this to include pre-primary, primary, and secondary school students.

C Mathematical Appendix

Proof of Lemma. I compute the level of income x such that a household with income x is indifferent between public and private education by solving $u[x, T, 0, E[s]] = u[x, T, e, 0]$:

$$\tilde{x} = \frac{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}{\gamma} E[s]$$

$\tilde{x}$ is larger than 0 and depends positively on $E[s]$. If x is greater (smaller) than $\tilde{x}$, $u[x, T, e, 0]$ is greater (smaller) than $u[x, T, 0, E[s]]$, and the household prefers private (public) education, which proves the Lemma. ■

Description of the Probabilistic Voting Mechanism.

Under probabilistic voting, I assume there are two political parties, p and q. Each party proposes a policy: s^p and s^q. These values of education quality imply fractions of public revenue going to education of T^p and T^q, respectively. A voter with income x experiences a utility gain of $u[x, T^q, e, s^q] - u[x, T^p, e, s^p]$ if party q wins the election instead of party p. The median voter model assumes that a voter votes for party q with probability 1 if this difference is positive. Probabilistic voting theory supposes that this vote is uncertain. The probability that a person votes for party q is given by:

$$F(u[x, T^q, e, s^q] - u[x, T^p, e, s^p]) \tag{18}$$

where F is an increasing and differentiable cumulative distribution function. This function captures the idea that voters care not only about the specific policy platform of each party, but also about an "ideology" variable. This concern for ideology is independent of the policy choice at hand, and makes the political choice inherently less predictable. The probability of voting for party q increases gradually as party q's platform becomes more attractive, and each party's vote share varies continuously with the proposed policy platform. This leads to smooth aggregation of all voters' preferences instead of sole dependence on the preferences of the median voter.

Both parties maximize their expected vote share, given by $\int_0^\infty g[x]F(\cdot)dx$. As the parties act symmetrically in equilibrium, $T = T^p = T^q$ and $s = s^p = s^q$. The maximization program of each party implements the maximum of the following weighted social welfare function:

$$\Omega[s] \equiv \int_0^\infty g[x]\ (F)'(0)\ u[x, T, e, s]\ dx$$

The weight $(F)'(0)$ captures the responsiveness of voters to a change in utility. Voters may be relatively non-responsive if they are highly ideologically biased, which means they do not punish or reward politicians much for economic policies that affect their utility. Policymakers accordingly place greater weight on the utility functions of less-ideological voters. The non-ideological voters most targeted by policymakers therefore enjoy disproportionate political power. Political power may additionally depend on features of the voting system, such as who has voting rights or who can offer campaign contributions to the policymaker. I can more broadly capture the relative political power of voters by introducing a parameter $\theta[x]$. The resulting objective function

maximized by the probabilistic voting mechanism is given by:

$$\Omega[s] \equiv \int_0^{\tilde{x}} u[x, T, 0, s]\, \theta[x]\, g[x]\, dx + \int_{\tilde{x}}^{\infty} u[x, T, e[x], 0]\, \theta[x]\, g[x]\, dx$$

For simplicity, I assume all voters have the same political power, which implies $\theta[x] = 1$, and gives me the maximization problem in (8). It can be shown that $\Omega[s]$ is strictly concave. Replacing $\tilde{x}$ with $2\sigma\Psi + 1 + r - \sigma$ in the objective, taking the first-order condition for a maximum, and solving for s yields equation (9). From the budget constraint, I then get equation (10).

Discussion of the Equilibrium.

In equilibrium, the choice of whether or not to participate in public school must be optimal. From the Lemma, the incentive to use private schooling is increasing in income. As a consequence, any equilibrium is characterized by an income threshold $\tilde{x}$ below which parents choose public education and above which they choose private education. This leads to the following definition of an equilibrium:

Definition (Equilibrium). An equilibrium consists of an income threshold $\tilde{x}$ satisfying equation (5), a private education decision $e = 0$ for $x < \tilde{x}$ and $e = e[x]$ for $x > \tilde{x}$, and aggregate variables (Ψ, s, T) given by equations (6), (9), and (10), such that perfect foresight holds:

$$E[s] = s \tag{19}$$

Proposition A.1. (Existence and uniqueness of equilibrium). *An equilibrium exists and is unique.*

The intuition for this result is simple. Equations (5) and (6) show that participation in public schooling is a continuously increasing function of expected public school quality. However, equation (9) shows that actual public school quality is a continuous and decreasing function of participation. Combining these results, I can construct a continuous and decreasing mapping from expected to actual school quality. The mapping has a unique fixed point, which characterizes the equilibrium.

Proof of Proposition A.1. The result follows from an application of Brouwer's fixed point theorem. By equation (9), the equilibrium expected public school quality $E[s]$ and the actual quality s lie in the following interval whose endpoints are computed by setting Ψ equal to 0 and 1:

$$E[s],\ s\ \in\ \left[\frac{y\gamma}{\eta+\gamma}, \frac{y\gamma}{\eta}\right] \tag{20}$$

I now define a mapping Δ from $E[s]$ into s, which maps this interval into itself. A unique equilibrium exists if this mapping has a unique fixed point.

Given $E[s]$, according to the Lemma and to equation (6), the fraction of families participating in public education is given by:

$$\Psi(E[s])\ =\ max\left\{min\left\{\frac{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}{2\gamma\sigma}E[s] - \frac{1+r-\sigma}{2\sigma}, 1\right\}, 0\right\} \tag{21}$$

This function is weakly increasing in $E[s]$; the higher the expected quality of public education, the more parents are going to prefer using the public sector.

I can now use equation (9) to map the expected education quality $E[s]$ into the actual education quality s that would result if $\Psi(E[s])$ of families participated in the public system. This education quality $s = \Delta(E[s])$ is given by:

$$\Delta(E[s]) \;=\; \frac{y\gamma}{\eta + \gamma\, max\left\{min\left\{\frac{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}{2\gamma\sigma}E[s] - \frac{1+r-\sigma}{2\sigma}, 1\right\}, 0\right\}} \tag{22}$$

An equilibrium is characterized by a fixed point of $\Delta(E[s])$, which is a schooling level s that satisfies $s = \Delta(s)$ so that the perfect foresight condition holds and parents expect a quality level s that is identical to the one implemented by the political process. Given equation (22), Δ is a continuous, weakly decreasing function, mapping the closed interval given in equation (20) into itself. The mapping therefore crosses the 45-degree line exactly once, and a unique equilibrium exists. ■

This assumption is common to most of the public finance literature on the public provision of education in a dual-provision regime. Since participation in public schools far exceeds 50% in nearly all countries, the literature notes that this is the empirically relevant case.

Proof of Propositions 1, 2, and 3. If I assume an interior solution (parameter values such that $\Psi \in (0, 1)$), I can solve for Ψ explicitly. There are two solutions, but only one is positive:

$$\Psi = \frac{-2\eta\sigma + \gamma(\sigma - 1 - r) + \sqrt{8y\gamma(1+\gamma)^{1+\frac{1}{\gamma}}\sigma + (\gamma(1+r-\sigma) - 2\eta\sigma)^2}}{4\gamma\sigma} \tag{23}$$

This formula allows me to write s and T as functions of the exogenous parameters. Taking partials and cross-partials of this expression, and of the expression for s and T, with respect to r, σ, and y, I establish Propositions 1, 2, and 3. ■

From these explicit formulas, the following proposition also follows:

Proposition A.2. (Revenue, income, inequality, and public education). *The following cross partial derivatives may have either sign:*

$$\frac{\partial\Psi}{\partial y\partial\sigma}, \quad \frac{\partial\Psi}{\partial y\partial r}, \quad \frac{\partial s}{\partial y\partial\sigma}, \quad \frac{\partial s}{\partial y\partial r} \;\lesseqgtr?\; 0$$

D Construction of Simulated Instrumental Variables

The construction of the simulated revenue variable follows techniques standard to the public finance literature. The exact redistribution algorithms defined by the FUNDEF (1998) and FUNDEB (2007) education finance reform laws provide me with an exogenous source of variation in municipal per capita revenue during 1998-2008. This variation is exogenous precisely because these laws were enacted by the federal government without regard for any specific municipality or state's revenue or education policies.

The FUNDEF law defined how revenue would be redistributed within states in a very careful algorithm, detailed in Ministério da Educação (2006). For 1998-1999, having data on the following variables allows one to determine how each municipality will fare under FUNDEF: total revenue of each municipality in the state, total revenue of the state government itself, total children enrolled in municipal primary schools in each municipality in the state, total children enrolled in state primary schools in the state, and the annually-set federal 'minimum expenditure per primary school student' amount. Given these variables alone, one can determine exactly which municipalities will be net winners, which will be net losers, and by how much.

During 2000-2004, the algorithm began to make the federal top-off amount vary based on the primary school level of students. Children in grades 1-4 of primary school were weighted differently than children in grades 5-8. During 2005-2006, the algorithm began to make federal top-off depend not only on the primary school level, but also on urbanization status. Thus, one would additionally need to know how many children were enrolled in grades 1-4 of urban primary schools, how many were enrolled in grades 1-4 of rural primary schools, how many were enrolled in grades 5-8 of urban primary schools, and how many were enrolled in grade 5-8 of rural primary schools. Beginning in 2007, under FUNDEB, the algorithm was complicated even more, to depend (in addition to all these previous factors) on the number of children enrolled in urban vs. rural creches, preschools, secondary schools, and adult education (EJA). Fortunately, the annual Census of Schools contains all of the required information, as it is the basis for the distribution of FUNDEF funds. Ministério da Educação (2008) describes the changes initiated in 2007.

While the laws induced endogenous municipal responses, I can simulate the municipality's virtual tax revenue by using the exact algorithms of the laws in each year, but using pre-reform (1997) data on revenue and enrollments. To better predict how enrollments will expand over the sample period without introducing endogenous information, I exploit the nation-wide rate at which municipal governments took over the state's role in primary education during 1998-2008. Primary education is usually run by municipal governments, but the state government is involved in some municipalities more than in others. I wanted to account for the fact that some municipalities had a greater potential to secure higher revenue through take-over than did others. The federal rate of takeover is exogenous to pre-primary education policy in any given municipality. However, by taking this into account and thus allowing simulated revenue to grow more in municipalities with heavy initial state and federal involvement in primary education in the pre-period, I can better predict revenue without drawing on any one municipality's endogenous response to the reforms.

The additional instruments are computed simply by interacting simulated revenue with the following variables: year 2000 median per capita household income, year 1997 average per capita income, the 2000 mean income divided by the 2000 median income, the 2000 Gini coefficient, and the 2000 DER income polarization index.

References

[1] **Aboud, Frances E.** (2006). "Evaluation of an Early Childhood Preschool Programme in Rural Bangladesh." *Early Childhood Research Quarterly*, 21: p. 46-60.

[2] **Alesina, Alberto, Reza Baqir, and William Easterly** (1999). "Public Goods and Ethnic Divisions." *Quarterly Journal of Economics*, 114(4): p. 1243-1284.

[3] **Anderson, Michael L.** (2008). "Multiple Inference and Gender Differences in the Effects of Early Intervention: A Reevaluation of the Abecedarian, Perry Preschool, and Early Training Projects," *Journal of the American Statistical Association*, 103(484): p. 1481-1495.

[4] **Abdelkrim, Araar and Jean-Yves Duclos** (2007). "DASP: Distributive Analysis Stata Package," PEP, World Bank, UNDP, and Université Laval.

[5] **Ames, Barry** (2001). *The Deadlock of Democracy in Brazil*. Ann Arbor: The University of Michigan Press.

[6] **Armecin, Graeme, Jere Behrman, and Paulita Duazo** (2006). "Early Childhood Development Through Integrated Programmes: Evidence From the Philippines." *World Bank Policy Research Working Paper*, No. 3922.

[7] **Avritzer, Leonardo** (2009). *Participatory Institutions in Democratic Brazil*. Baltimore: Johns Hopkins University Press.

[8] **Auyero, Javier** (2001). *Poor People's Politics: Peronist Suvival Networks and the Legacy of Evita*. Durham: Duke University Press.

[9] **Banerjee, Abhijit and Rohini Somanathan** (2007). "The political economy of public goods: Some evidence from India." *Journal of Development Economics*, 82: p. 287-314.

[10] **Bardhan, Pranab and Dilip Mookherjee** (2006). "Pro-poor Targeting and Accountability of Local Governments in West Bengal." *Journal of Development Economics*, 79: p. 303-327.

[11] **Bartels, Larry** (2009). "Economic Equality and Political Representation." In Lawrence R. Jacobs and Desmond S. King, eds., *The Unsustainable American State*. Oxford: Oxford University Press.

[12] **Barzel, Yoram** (1973). "Private Schools and Public School Finance." *The Journal of Political Economy*, 81(1): p. 174-186.

[13] **Bates, Robert** (1973). *Ethnicity in Contemporary Africa*. Monograph, Program of Eastern African Studies, XIV, Maxwell School of Citizenship and Public Affairs: Syracuse University.

[14] **Bates, Robert** (1976), *Rural Responses to Industrialization: A Study of a Village in Zambia*. Yale University Press, New Haven.

[15] **Bates, Robert** (1981), *States and Markets in Tropical Africa: The Political Basis of Agricultural Policy*. Berkeley: University of California Press, Series on Social Choice and Political Economy.

[16] **Benabou, Roland** (2000). "Unequal Societies: Income Distribution and the Social Contract." *American Economic Review*, 90(1): p. 96-129.

[17] **Berlinski, Samuel, Sebastian Galiani, and Marco Manacorda** (2008). "Giving Children a Better Start: Preschool Attendance and School-Age Profiles." *Journal of Public Economics*, 92(5-6): p. 1416-1440.

[18] **Berlinski, Samuel, Sebastian Galiani, and Paul Gertler** (2009). "The Effect of Pre-primary Education on Primary School Performance." *Journal of Public Economics*, 93(1-2): p. 219-234.

[19] **Besley, Timothy and Stephen Coate** (1991). "Public Provision of Private Goods and the Redistribution of Income." *The American Economic Review* 81(4): p. 979-984.

[20] **Besley, Timothy and Robin Burgess** (2002). "The Political Economy of Government Responsiveness: Theory and Evidence from India." *The Quarterly Journal of Economics* 117(4): p. 1415-1451.

[21] **Blundell, Richard, Alan Duncan, and Costas Meghir** (1998). "Estimating Labor Supply Responses to Using Tax Reforms." *Econometrica*, 66(4): p. 827-861.

[22] **Boulding, Carew and Brian Wampler** (2010). "Voices, Votes, and Resources: Evaluating the Effect of Participatory Democracy on Well-being." *World Development*, 38(1): p. 125-135.

[23] **Campbell, Frances A., Craig T. Ramey, Elizabeth Pungello, Joseph Sparling, and Shari Miller-Johnson** (2002). "Early Childhood Education: Young Adult Outcomes from the Abecedarian Project." *Applied Developmental Science*, 6(1): p. 42-57.

[24] **Card, David, and Abigail Payne** (2002). "School Finance Reform, the Distribution of School Spending, and the Distribution of Student Test Scores." *Journal of Public Economics*, 83: p. 49-82.

[25] **Carneiro, Pedro Manuel, and James Heckman** 2003. "Human Capital Policy." In James Heckman and Anne Krueger, eds., *Inequality in America: What Role for Human Capital Policies?* Boston: MIT Press.

[26] **Cascio, Elizabeth** (2009). "Do Investments in Universal Early Education Pay Off? Long-term Effects of Introducing Kindergartens into Public Schools." *NBER Working Paper No. 14951.*

[27] **Chambers, Robert** (1983). *Rural Development: Putting the Last First.* New York: Prentice Hall.

[28] **Chandra, Kanchan** (2004). *Why Ethnic Parties Succeed: Patronage and Ethnic Head Counts in India.* Cambridge: Cambridge University Press.

[29] **Chetty, Raj, John N. Friedman, Nathaniel Hilger, Emmanuel Saez, Diane Whitmore Schanzenbach, and Danny Yagan** (2010). "How Does Your Kindergarten Classroom Affect Your Earnings? Evidence from Project Star." *NBER Working Paper 16381.*

[30] **Couto, Cláudio, and Fernando Luiz Abrucio** (1995). Governando a Cidade? A Força e a Fraqueza da Câmara Municipal." *São Paulo em Perspectiva*, 9, p. 57-65.

[31] **Cunha, F., J. Heckman, L. Lochner, and D. Masterov** (2006). "Interpreting the Evidence on Life Cycle Skill Formation." In E. Hanushek and F. Welch, eds., *Handbook of the Economics of Education.* Amsterdam: Elsevier.

[32] **Currie, Janet** (2001), "Early Childhood Education Programs." *Journal of Economic Perspectives*, 15: p. 213-238.

[33] **Currie, Janet and Thomas, Duncan** (1995), "Does Head Start Make a Difference?" *American Economic Review*, 85: p. 341-364.

[34] **Engle, Patrice L., Maureen M. Black, Jere R. Behrman, Meena Cabral de Mello, Paul J. Gertler, Lydia Kapiriri, Reynaldo Martorell, and Mary Eming Young** (2007). "Child Development in Developing Countries." *The Lancet*, 369: p. 229-242.

[35] **Epple, Dennis, and Richard Romano** (1996). "Ends Against the Middle: Determining Public Service Provision When There are Private Alternatives." *Journal of Public Economics*, 62: p. 297-325.

[36] **Estevan, Fernanda** (2007). "The Quality of Public Education and Private school Enrollment: An Assessment Using Brazilian Data." *Working Paper.*

[37] **Evans, David and Katrina Kosec** (2010). "Access to Early Childhood Education in Brazil." *Working Paper.*

[38] **Ferraz, Claudio and Frederico Finan** (2009a). "Electoral Accountability and Corruption: Evidence from the Audits of Local Governments." *NBER Working Paper 14937.*

[39] **Ferraz, Claudio and Frederico Finan** (2009b). "Motivating Politicians: The Impacts of Monetary Incentives on Quality and Performance." *NBER Working Paper 14906.*

[40] **Ferreira, Francisco H.G., Peter Lanjouw, and Marcelo Neri** (2003). "A New Poverty Profile for Brazil Using PPV, PNAD and Census Data." *Revista Brasileira de Economia*, 57(1): p. 59-92.

[41] **Fitzpatrick, Maria D.** (2008). "Starting School at Four: The Effect of Universal Pre-Kindergarten on Children's Academic Achievement." *The B.E. Journal of Economic Analysis and Policy*, 8(1).

[42] **Foster, Andrew and Mark Rosenzweig** (2002). "Democratization, Decentralization and the Distribution of Local Public Goods in a Poor Rural Economy." *BREAD Working Paper No. 010.*

[43] **Glomm, Ravikumar and Gerhard Glomm** (1998). "Opting Out of Publicly Provided Services: A Majority Voting Result." *Social Choice Welfare*, 15: p. 187-199.

[44] **Gordon, Nora** (2004). "Do Federal Grants Boost School Spending? Evidence from Title I." *Journal of Public Economics*, 88(9-10): p. 1771-1792.

[45] **Gordon, Nora, and Emiliana Vegas** (2005). "Educational Finance, Equalization, Spending, Teacher Quality, and Student Outcomes: The Case of Brazil's FUNDEF." In Incentives to Improve Teaching: Lessons From Latin America, Ed. Emiliana Vegas. The World Bank: Washington, D.C.

[46] **Gormley, William Jr., Deborah Phillips, Shirley Adelstein, and Catherine Shaw** (2010). "Head Start's Comparative Advantage: Myth or Reality?" Forthcoming, *Policy Studies Journal.*

[47] **Grossman, Gene and Elhanan Helpman** (1994). "Protection For Sale" *The American Economic Review*, 84(4): p. 833-850.

[48] **Gutierrez, Catalina, and Ryuichi Tanaka** (2009). "Inequality and Education Decisions in Developing Countries" Forthcoming, *Journal of Economic Inequality*, 7: p. 55-81.

[49] **Heckman, James and Dimitriy V. Masterov** (2007). "The Productivity Argument for Investing in Young Children." Working Paper.

[50] **Hoxby, Caroline M.** (2001). "All School Finance Equalizations are not Created Equal." *Quarterly Journal of Economics*, 116(4): p. 1289-1231.

[51] **Instituto Brasileiro de Geografia e Estatística (IBGE)** (2007). "2007 Regional Accounts Report." $http://www.ibge.gov.br/english/estatistica/economia/contasregionais/2003_2007/default.shtm$

[52] **Jaffrelot, Christophe** (2003). *Indias Silent Revolution: The Rise of the Lower Castes in North India*. New York: Columbia University Press.

[53] **Jaramillo, Adriana and Karen Tietjen** (2001). "Early Childhood Development in Africa: Can We Do More or Less? A Look at the Impact and Implications of Preschools in Cape Verde and Guinea." *World Bank, Africa Region Human Development Working Paper Series*.

[54] **Jha, Saumitra, Vijayendra Rao, and Michael Woolcock** (2007). "Governance in the Gullies: Democratic Responsiveness and Leadership in Delhi's Slums." *World Development*, 35(2): p. 230-246.

[55] **Keefer, Philip, and Stuti Khemani** (2005). "Democracy, Public Expenditures, and the Poor: Understanding Political Incentives for Providing Public Services." *The World Bank Research Observer*, 20(1): p. 1-27.

[56] **Knack, Stephen and Philip Keefer** (1997). "Does Inequality Harm Growth Only in Democracies? A Replication and Extension." *American Journal of Political Science*, 41(1): p. 323-332.

[57] **Knudson, Eric, James Heckman, Judy Cameron, and Jack Shonkoff** (2006). "Economic, Neurobiological, and Behavioral Perspectives on Building America Future Workforce." *Proceedings of the National Academy of Sciences*, 103(27): p. 10155-10162.

[58] **Love, John M. Kisker, Ellen Eliason, Christine Ross, Helen Raikes, Jill Constantine, Kimberly Boller, Jeanne Brooks-Gunn, Rachel Chazan-Cohen, Louisa Banks Tarullo, Christy Brady-Smith, Allison Sidle Fuligni, Peter Z. Schochet, Diane Paulsell, and Cheri Vogel** (2005). "The Effectiveness of Early Head Start for 3-year-old Children and their Parents: Lessons for Policy and Programs." *Developmental Psychology*, 41(6): p. 885-901.

[59] **Mansuri, Ghazala and Vijayendra Rao** (2004). "Community-Based and -Driven Development: A Critical Review." *The World Bank Research Observer*, 19(1): p. 1-39.

[60] **Martínez-Fritscher, André, Aldo Musacchio, and Martina Viarengo** (2010). "The Great Leap Forward: The Political Economy of Education in Brazil, 1889-1930."

[61] **Melo, Marcus André** (2009). "Democratizing Budgeting Decisions and Execution in Brazil: More Participatation or Redesign of Formal Institutions?" In Andrew Selee and Enrique Peruzzotti, eds., *Participatory Innovation and Representative Democracy in Latin America*. Baltimore: The Johns Hopkins University Press.

[62] **Meltzer, A. and S. Richard** (1981). "A Rational Theory of the Size of Government." *Journal of Political Economy*, 89(5): p. 914-927.

[63] **Ministério da Educação** (2008). "FUNDEB: Manual de Orientação."
$http://www.fnde.gov.br/index.php/fundeb-publicacoes$

[64] **Ministério da Educação** (2006). "Legislação."
$http://www.fnde.gov.br/index.php/fundef-legislacao$

[65] **Patrinos, Harry A.** (2007). "The Living Conditions of Children." World Bank Policy Research Working Paper No. 4251.

[66] **Plank, David N.** (1996). *The Means of Our Salvation: Public Education in Brazil, 1930-1995.* Boulder: Westview Press.

[67] **Rock, David** (1996). "Machine Politics in Buenos Aires and the Argentine Radical Party, 1912-1930." *Journal of Latin American Studies,*, 4(2): p. 233-256.

[68] **Sands, Joseph C. Jr.** (2008). "Education Funding in a Recentralizing Democracy: A Cautionary Tale of Four Brazilian Cities." *Latin American Politics and Society*, 50(3): p. 93-120.

[69] **Schweinhart, L., Montie, J., Xiang, Z., Barnett, W. S., Belfield, C., and Nores, M.** (2005). "Lifetime Effects: The High/Scope Perry Preschool Study Through Age 40." Ypsilanti, Michigan: High/Scope Press.

[70] **Shah, Anwar** (2007). *Participatory Budgeting.* Washington, DC: The World Bank.

[71] **Skidmore, Thomas** (2004). "Brazil's Persistent Income Inequality: Lessons From History." *Latin American Politics and Society*, 46(2): p. 133-150.

[72] **Souza, Celina** (1997). "Constitutional Engineering in Brazil: The Politics of Federalism and Decentralization." Houndmills and London: Macmillan; New York: St. Martin's Press.

[73] **Souza, Celina** (2001). "Participatory Budgeting in Brazilian Cities: Limits and Possibilities in Building Democratic Institutions." *Environment and Urbanization*, 13(1): p. 159-184.

[74] **Souza, Celina** (2002). "Brazil: the Prospects of a Center-Constraining Federation in a Fragmented Polity." *Publius: The Journal of Federalism*, 32(2): p. 23-48.

[75] **Souza, Celina** (2005). "Brazil's Tax System: The Dilemmas of Policy Reform." FOCAL Policy Paper 05-02.

[76] **Souza, Paulo Renato** (2005). *A Revolução Gerenciada: Educação no Brasil 1995-2002.* Prentice Hall: São Paulo.

[77] **Stiglitz, Joseph** (1974). "The Demand for Education in Public and Private School Systems." *Journal of Public Economics*, 3(4): p. 349-385.

[78] **United Nations Educational, Scientific, and Cultural Organization (UNESCO), Education for All** (2006). "Strong Foundations: Early Childhood Care and Education." *EFA Global Monitoring Report.* UNESCO Publishing: Paris.

[79] **United Nations Educational, Scientific, and Cultural Organization (UNESCO)** (2007). "Policy Review Report: Early Childhood Care and Education in Brazil." UNESCO Education Sector, Early Childhood and Family Policy Series No. 13-2007.

[80] **U.S. Department of Health and Human Services** (2010). "Head Start Impact Study Final Report."

[81] **Varshney, Ashutosh** (1995). *Democracy, Development, and the Countryside: Urban-Rural Struggles in India.* New York: Cambridge University Press.

[82] **Wampler, Brian** (2007). *Participatory Budgeting in Brazil: Contestation, Cooperation and Accountability.* Pennsylvania State University Press: Pennsylvania.